F1 SERIES

Vehicle application

S23

S23 ENT C

S30

S30 ENT C

Technical and Repair manual

This publication describes the characteristics, data and correct methods for repair operations on each component of the vehicle.

If the instructions provided are followed and the specified equipment is used, correct repair operations in the programmed time will be ensured, safeguarding against possible accidents.

Before starting to perform whatever type of repair, ensure that all accident prevention equipment is available and efficient.

All protections specified by safety regulations, i.e.: goggles, helmet, gloves, boot, etc. must be checked and worn.

All machining, lifting and conveying equipment should be inspected before use.

Publication edited by
Iveco Motors
Iveco SpA
PowerTrain
Mkt. Advertising & Promotion
Viale dell'Industria, 15/17
20010 Pregnana Milanese
Milano (Italy)
Print **P1D32S001GB** - 2nd Ed. 02.2005
1st Updating 02.2006

Produced by:

SATIZ msx INTERNATIONAL

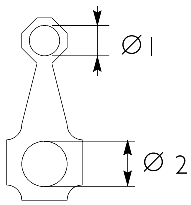
B.U. TECHNICAL PUBLISHING
Iveco Technical Publications
Lungo Stura Lazio, 15/19
10156 Turin - Italy

F1 ENGINES

SPECIAL REMARKS

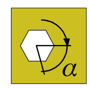
Where possible, the same sequence of procedures has been followed for easy reference.
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

Example



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings



Tighten to torque
Tighten to torque + angular value

PRELIMINARY REMARKS

Manuals for repairs are split into Sections, each one of which is marked by a numeral; the contents of these sections are indicated in the general table of contents.
Each section is generally dedicated to a main Unit (e.g.: engine, gearbox, electric system, etc.).
Sections with mechanical contents include technical data, tightening torque collections, tool lists, connections – disconnections of units to/from the vehicle, overhauls at the bench and relating troubleshooting.
On the electric/electronic system section there are the descriptions of the electric network and vehicle electronic systems, electric schemes, components electric characteristics, components codes and troubleshooting relating to the central units specific of the electric system.
The manual uses proper symbols in its descriptions; the purpose of these symbols is to classify contained information. In particular, there have been defined a set of symbols to classify warnings and a set for assistance operations.

SYMBOLS - WARNINGS

Danger for persons
Missing or incomplete observance of these prescriptions can cause serious danger for persons' safety.

Danger of serious damage for the vehicle
Partial or complete non observance of these prescriptions can cause serious damages to the vehicle and sometimes guarantee lapse too.

General danger
It includes the dangers of above described signals.

Environment protection
It indicates correct behaviour in order that vehicle use is environmentally friendly as much as possible.

NOTE It indicates an additional explanation for a piece of information.

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Graph and symbols

	Removal Disconnection
	Refitting Connection
	Removal Disassembly
	Fitting in place Assembly
	Tighten to torque
α	Tighten to torque + angle value
	Press or caulk
	Regulation Adjustment
!	Warning Note
	Visual inspection Fitting position check
	Measurement Value to find Check
	Equipment
	Surface for machining Machine finish
	Interference Strained assembly
	Thickness Clearance
	Lubrication Damp Grease
	Sealant Adhesive
	Air bleeding

	Intake
	Exhaust
	Operation
ϱ	Compression ratio
	Tolerance Weight difference
	Rolling torque
IVECO PARTS	Replacement Original spare parts
	Rotation
	Angle Angular value
	Preload
	Number of revolutions
	Temperature
bar	Pressure
>	Oversized Higher than…. Maximum, peak
<	Undersized Less than…. Minimum
	Selection Classes Oversizing
	Temperature < 0 °C Cold Winter
	Temperature > 0 °C Hot Summer

Part 1
F1A ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the F1A engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

Section 3 relates to the specific duty and is divided in four separate parts:

1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.

Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.

Installation general prescriptions are reported within the appendix.

The appendix reports general safety prescriptions to be followed by all operators whether being in-charge of installation or maintenance, in order to avoid serious injury.

UPDATING

Section	Description	Page	Date of revision

SECTION 1

General specifications

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F1AE0481B*A0..	S23 ENT C
F1AE0481B*B0..	S23 ENT C
F1AE0481A*....	-

LUBRICATION

General

The engine is lubricated by forced circulation performed by the following parts:

- An oil gear pump is incorporated in an assembly that also includes the vacuum pump (GPOD).
- A pressure control valve incorporated in the crankcase.
- A Modine-type heat exchanger with built-in safety valve.
- A double filtration oil filter with built-in safety valve.

Operation (see Figure 1)

Engine oil is drawn up from the sump by the oil pump (3) via the suction strainer (2) and delivered under pressure to the heat exchanger (5) where it is cooled.
The oil continues through the oil filter (6) and goes to lubricate the relevant parts through ducts or pipes.
At the end of the lubrication cycle, the oil returns to the sump by gravity. The oil filter can be excluded by the safety valve built into it if it gets clogged. The heat exchanger is also excluded by a safety valve if it gets clogged.
In addition, the lubrication oil supplies the hydraulic automatic tightener (7) of the camshaft drive (8).

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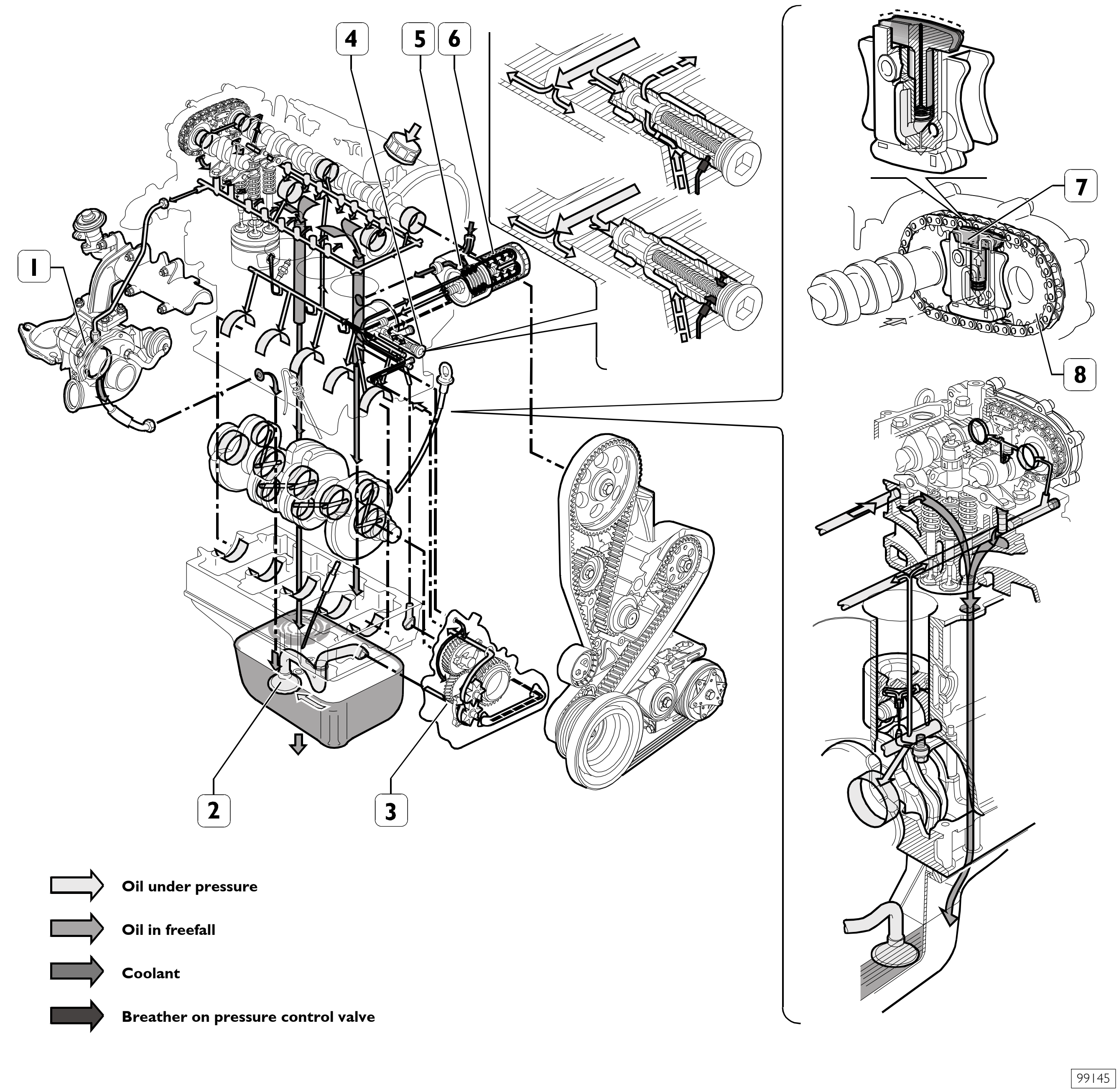
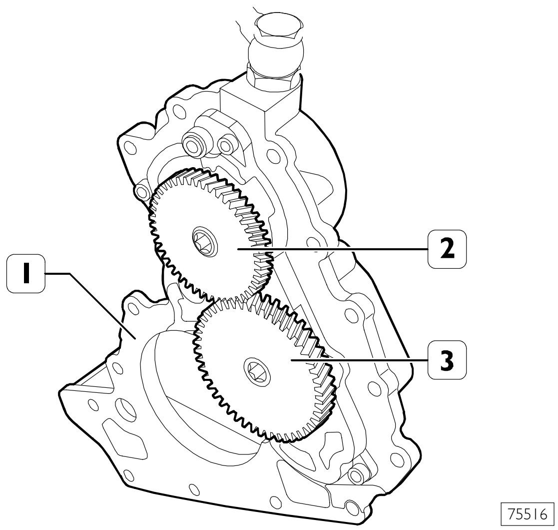
Figure 1


4
5
6
1
7
8
2
3
Oil under pressure
Oil in freefall
Coolant
Breather on pressure control valve
99145

Oil pump

Figure 2



The oil pump (3) is a gear pump driven directly by the crankshaft.

Characteristic data

transmission ratio	1.15	
displacement	16.2	cm^3
pumping diameter	49.5	mm
number of teeth	7	
height	11	
oil pump minimum speed	862	rpm
oil pump max. speed	4485	rpm
oil pump over-revs	5247	rpm
oil pump forced over-revs	6279	rpm
speed	2500	rpm
torque	2.1	Nm
power draw (calc.)	550	W

Oil temperature: 100°C – closed recirculation – max. outlet pressure 5 bars	
engine speed rpm (oil pump speed – rpm)	capacity (l/min)
750 (862)	12
3900 (4485)	68

Vacuum pump

The vacuum pump (2, Figure 2), with radial blades, is also incorporated in the GPOD (1, Figure 2). It is driven directly by the oil pump.

transmission ratio	3.25	
displacement	86	cm^3
volume to drain	4.5	litres
volume to drain with EGR	9	litres
chamber diameter	65	mm
rotor diameter	50	mm
cam	7.5	mm
number of blades	3	
height	34	mm
vacuum pump minimum speed	994	rpm
vacuum pump max. speed	5168	rpm
vacuum pump over-revs	6046	rpm
vacuum pump forced over-revs	7235	rpm
theoretical flow rate at minimum (air)	85.5	l/min
actual flow rate at minimum (air) – at atmospheric pressure	46	l/min
Theoretical speed at max. speed – (air)	444.4	l/min
Actual flow rate at max. speed – (air) at atmospheric pressure	60	l/min

measured power draw (maximum)		
speed	2500	rpm
torque	2.1	Nm
power draw (calc.)	550	W

Oil temperature: 100°C – engine speed 750 rpm (pump speed 994 rpm)			
tank (litres)	vacuum (bar)	0,5	0,8
4,5	time (sec)	4,5	12,5
5,6		6,0	16,0
9		9,0	24,0

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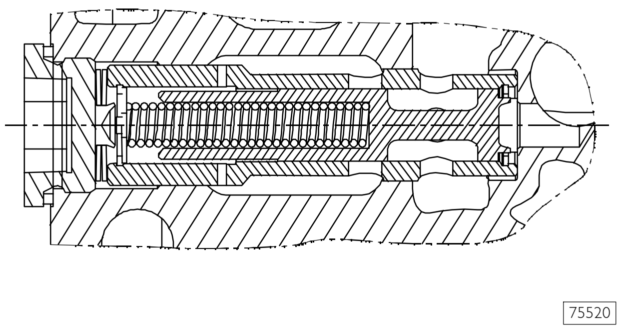
Oil pressure control valve

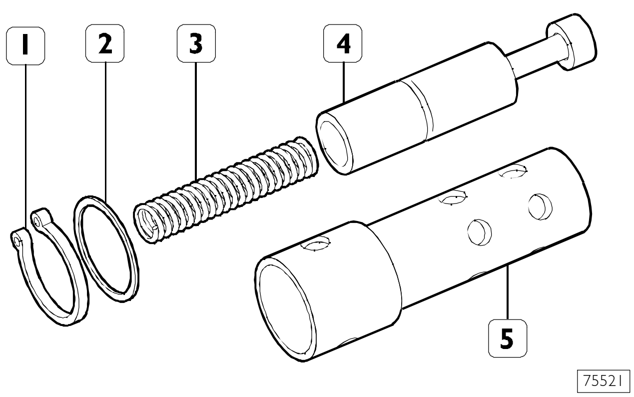
Figure 3



CROSS-SECTION OF OIL PRESSURE CONTROL VALVE MOUNTED IN CRANKCASE

Valve removed from crankcase L = 51.75 mm.
Valve fitted in crankcase L = 50.75 mm.
Start of opening 4 bar L = 49.5
maximum opening 4.6 bar L = 44.

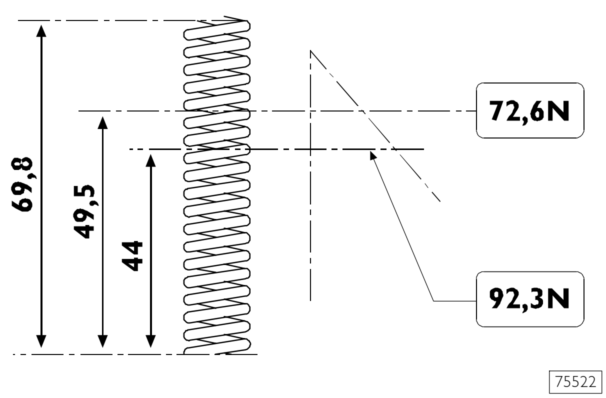
Figure 4



PARTS COMPRISING THE OIL PRESSURE CONTROL VALVE

1. Split ring – 2. Washer – 3. Spring – 4. Valve – 5. Valve casing.

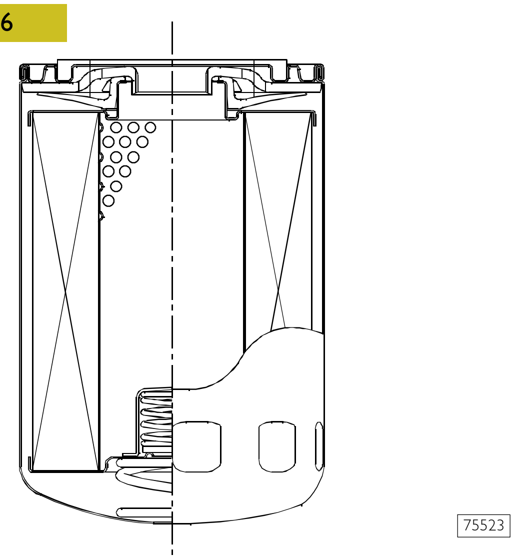
Figure 5



MAIN DATA OF THE OIL PRESSURE CONTROL VALVE SPRING

Oil filter

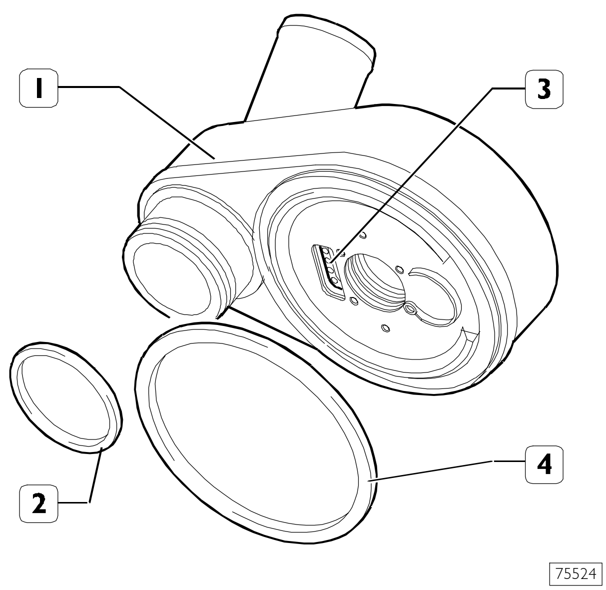
Figure 6



Oil filter with single filtration with built-in by-pass valve – opening pressure 2.5 ± 0.3 bar.

Modine heat exchanger

Figure 7



Thoroughly clean the heat exchanger (1).
Always change the seals (2 and 4).
Built-in safety valve (3).

Opening pressure	0.82 - 1.03 bar

Oil vapour recirculation system

Description

The oil vapours formed in the sump while the engine is running, passing through the overhead cover, are channelled into the separator / condenser filter known as the blow-by. The filter is structured in two sections:

- The first one with a labyrinth, where most of the vapours are condensed and return to the sump through an umbrella outlet valve.
- The second one includes a coalescence filter that condenses the remaining vapours that return to the sump through another umbrella valve.

The portion of vapour that has not condensed is sent, via a MANN-HUMMEL valve, to the intake duct and burnt during normal engine operation.

NOTE The blow-by filter cannot be taken apart and must therefore be replaced entirely.

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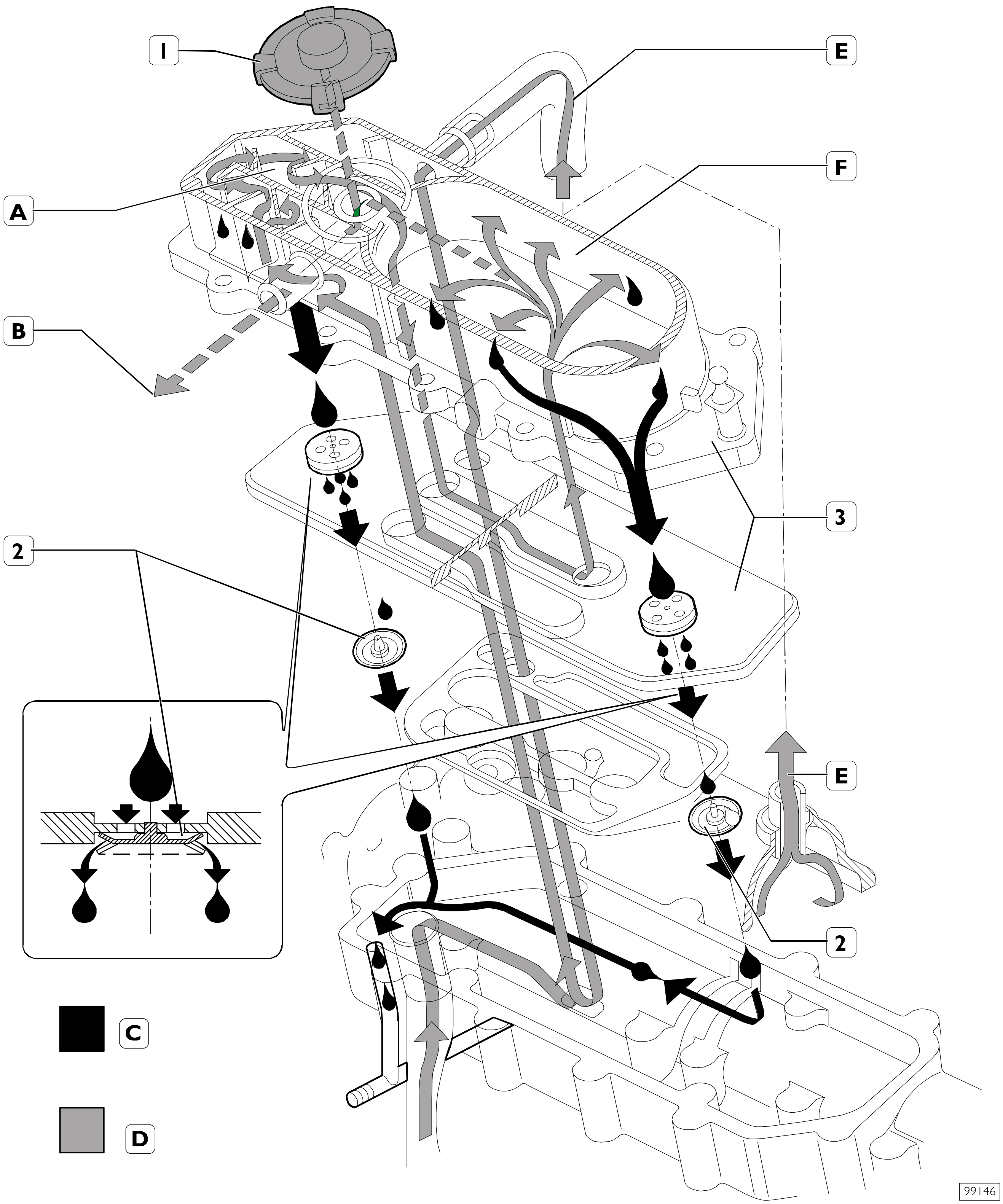
Figure 8



OIL VAPOUR RECIRCULATION DIAGRAM

1. MANN-HUMMEL valve – 2. Umbrella valves – 3. Blow-by filter – A. Labyrinth – B. Intake oil vapour recovery flow – C. Oil return flow into sump – D. Flow of oil vapours from the sump – E. Flow of oil vapours from the overhead – F. Coalescence filter.

COOLING

Description

The engine cooling system is the type with forced circulation in a closed circuit. It comprises the following parts:

- An expansion tank whose plug has two valves incorporated in it: an outlet and an inlet, which govern the pressure of the system.
- A coolant level sensor at the base of the expansion tank.
- An engine cooling module to dissipate the heat taken from the engine by the coolant with a heat exchanger for the intercooler.
- A heat exchanger to cool the lubricating oil.
- A heat exchanger to cool the exhaust gases (engines with EGR - if present).
- A centrifugal water pump incorporated in the crankcase.
- An electric fan comprising an electromagnetic coupling on whose shaft a hub turns idle that is fitted with an axially mobile metal plate on which is mounted the impeller.
- A 3-way thermostat governing the circulation of the coolant.

Operation

The water pump driven by a poly-V belt by the crankshaft sends coolant into the crankcase and with a greater head into the cylinder head.
When the coolant temperature reaches and exceeds the working temperature, it causes the thermostat to open and the fluid is channelled from here to the radiator and cooled by the fan.
The pressure in the system due to the change in temperature is governed by the outlet (2) and inlet (1) valves incorporated in the expansion tank filler plug (detail A).
The outlet valve (2) has a twofold function:

- to keep the system slightly pressurized so as to raise the boiling point of the coolant;
- to discharge into the atmosphere the excess pressure produced in case of high coolant temperatures.

The function of the inlet valve (1) is to permit transferring the coolant from the expansion tank to the radiator when a lower pressure is created in the system due to the reduction in volume of the coolant as a result of its temperature lowering.
Outlet valve opening 1 ± 0.1 kg/cm^2.
Inlet valve opening 0.005 – 0.02 kg/cm^2.

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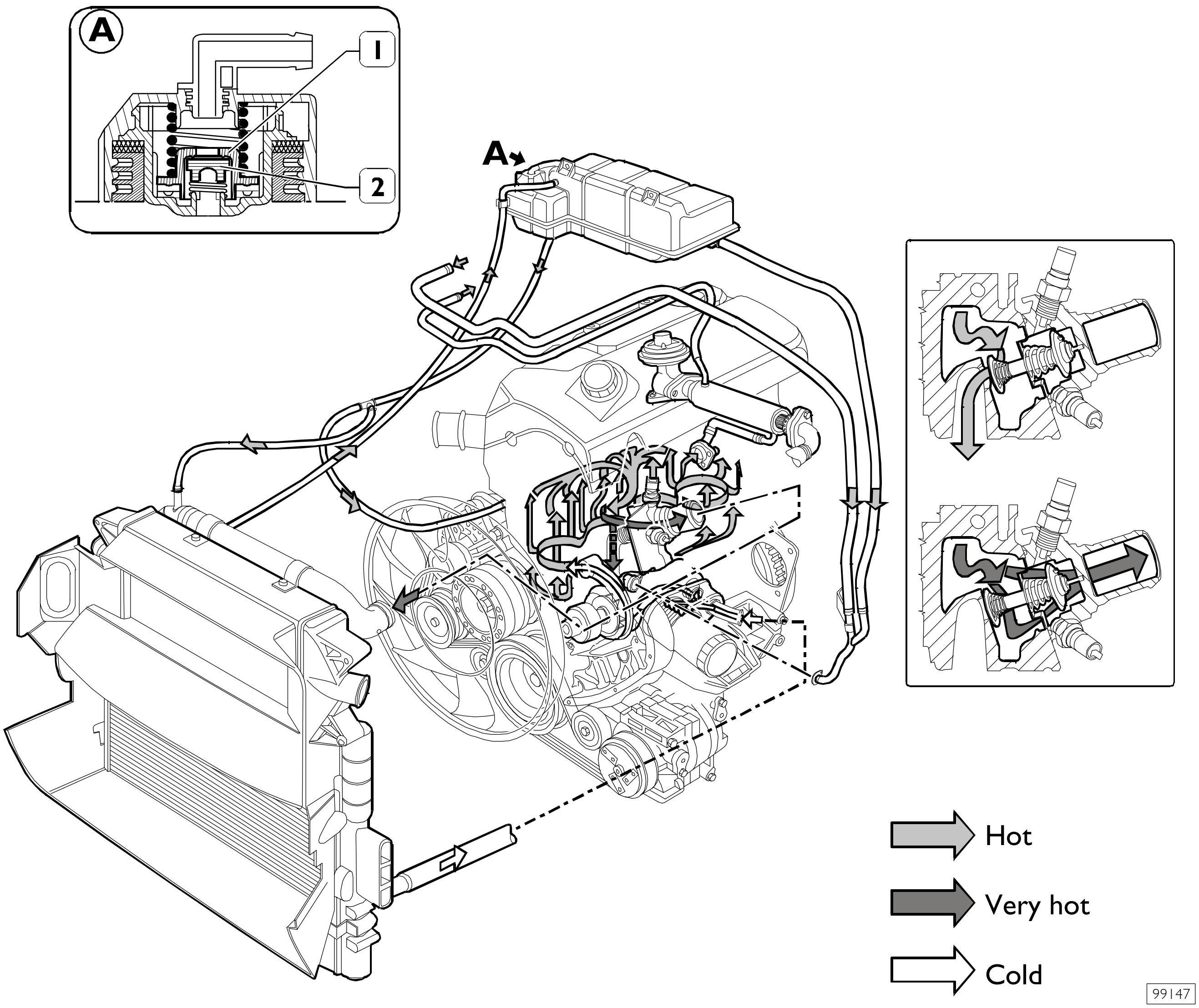
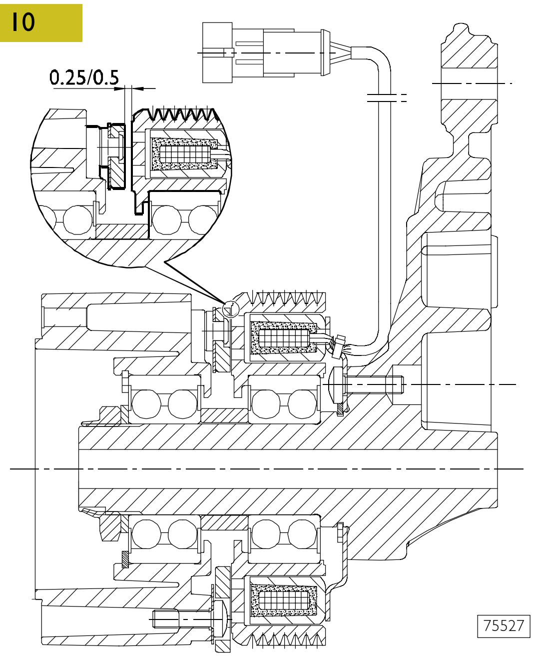
Figure 9 (If available)



Electromagnetic pulley (if present)

Figure 10



CROSS-SECTION OF THE ELECTROMAGNETIC JOINT

Characteristics

Transmissible torque at 20°C with clutch run in	45 Nm
Voltage	12 Volts
Power input	26 W

The electric fan control relay is activated or deactivated according to the temperatures of: the engine coolant, the fuel supercharging air and the pressure of the air conditioner fluid (if present).

Coolant temperature
(if the sensor is not defective)
It activates at > 96°C and deactivates at < 84°C.

Turbocharging air temperature
It activates at > 75°C and deactivates at < 65°C.

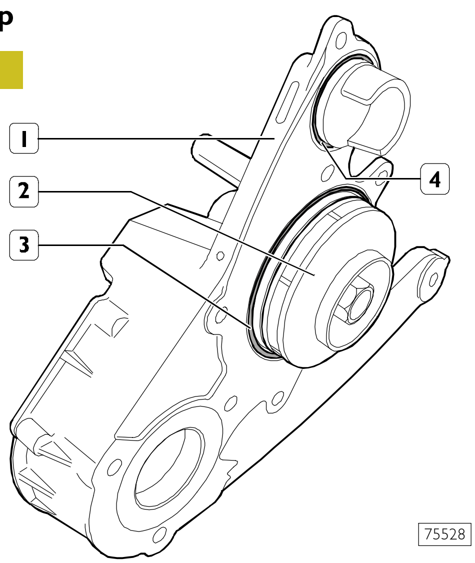
Fuel temperatures
(if the coolant temperature sensor is acknowledged to be defective by the EDC control unit)
It activates at > 20°C and deactivates at < 10°C.

With climate control system
With pressure in the system

it turns on	18.5 ± 0.98 bar
it turns off	14.58 ± 0.98 bar

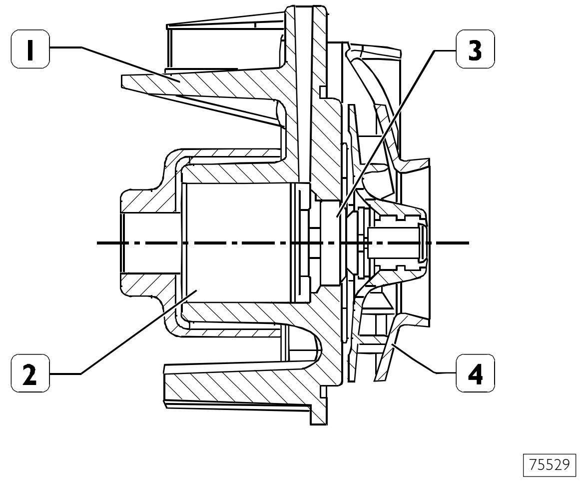
Water pump

Figure 11



The water pump (3) cannot be overhauled. In case of coolant leaking from the seal or damage, it must be replaced. The water pump casing (1) is also used as a mounting for the high-pressure pump. The seals (3 and 4) must always be replaced.

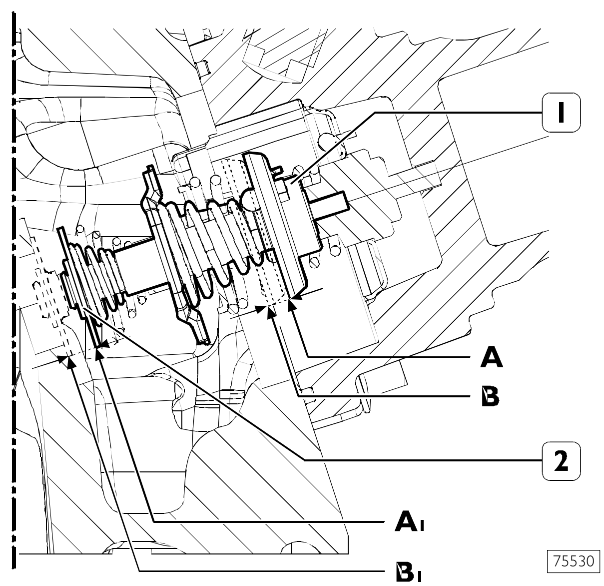
Figure 12



LONGITUDINAL CROSS-SECTION OF THE WATER PUMP
1. Pump casing – 2. Pump drive shaft together with bearing – 3. Seal – 4. Impeller.

Thermostat

Figure 13



The by-pass thermostat (1) needs no adjustment.
If there is any doubt about its operation, replace it.
The thermostat casing is fitted with the thermometric switch/transmitter and water temperature sensor.

A. – A1 Start of stroke at 78°C ±2°C.
B. Valve (1) stroke at 94°C = 7 mm.
B1 Valve (2) stroke 94°C, 6.4 mm
The stroke of 7 mm less than 60''.

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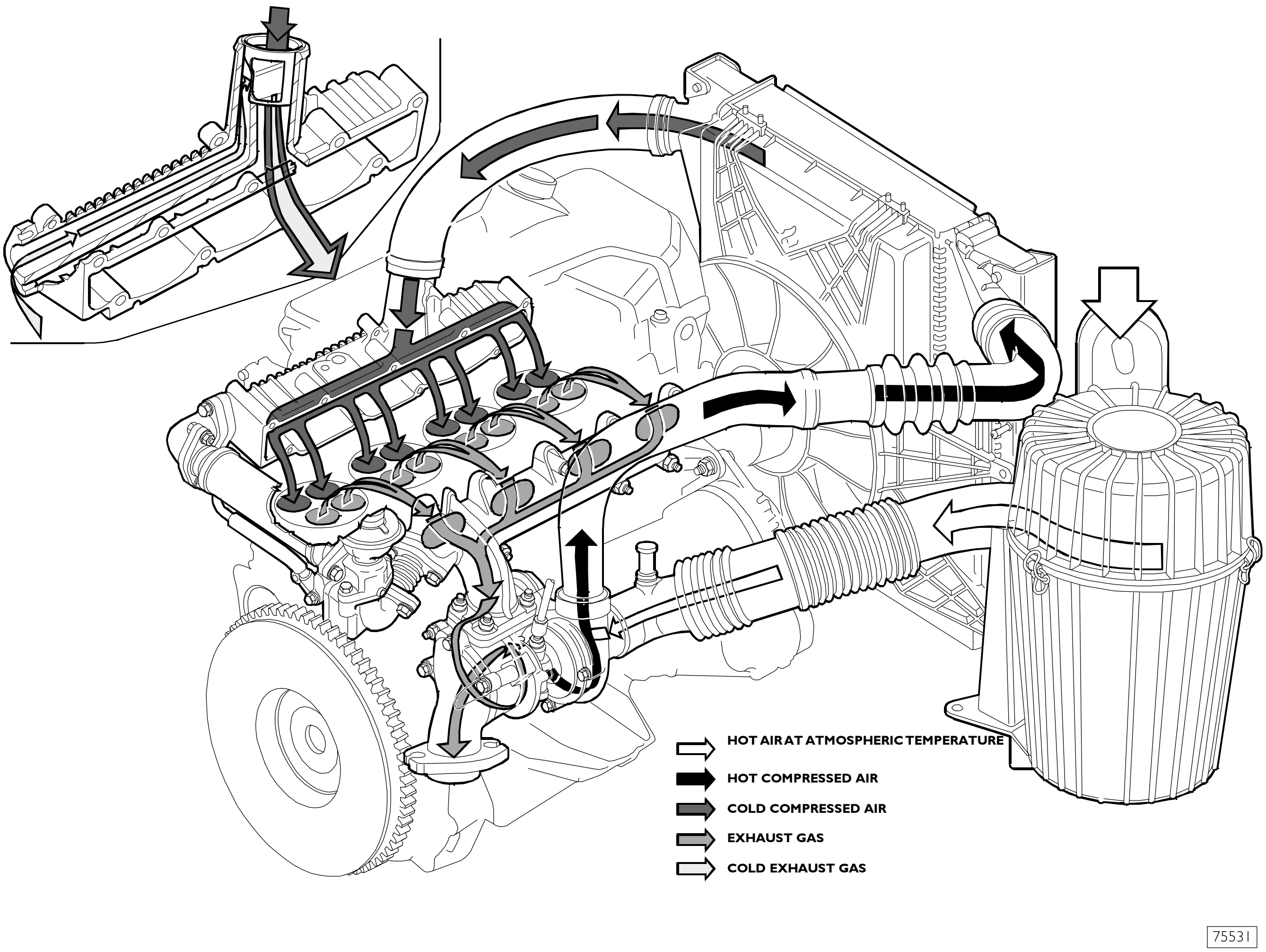
TURBOCHARGING

Figure 14 (If available)



TURBOCHARGING DIAGRAM

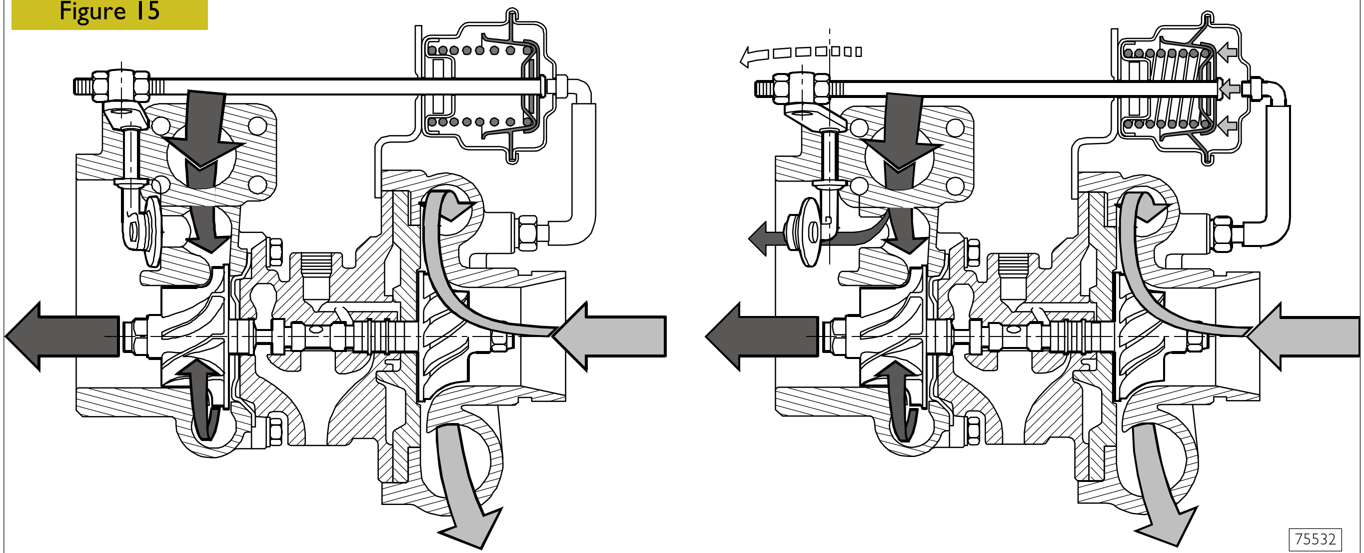
Description

The turbocharging system comprises an air filter, turbocharger and intercooler.
The air filter is the dry type comprising a filtering cartridge to be periodically replaced.

The function of the turbocharger is to use the energy of the engine's exhaust gas to send pressurized air to the cylinders.
The intercooler comprises a radiator included in the engine coolant radiator and its function is to lower the temperature of the air leaving the turbocharger to send it to the cylinders.

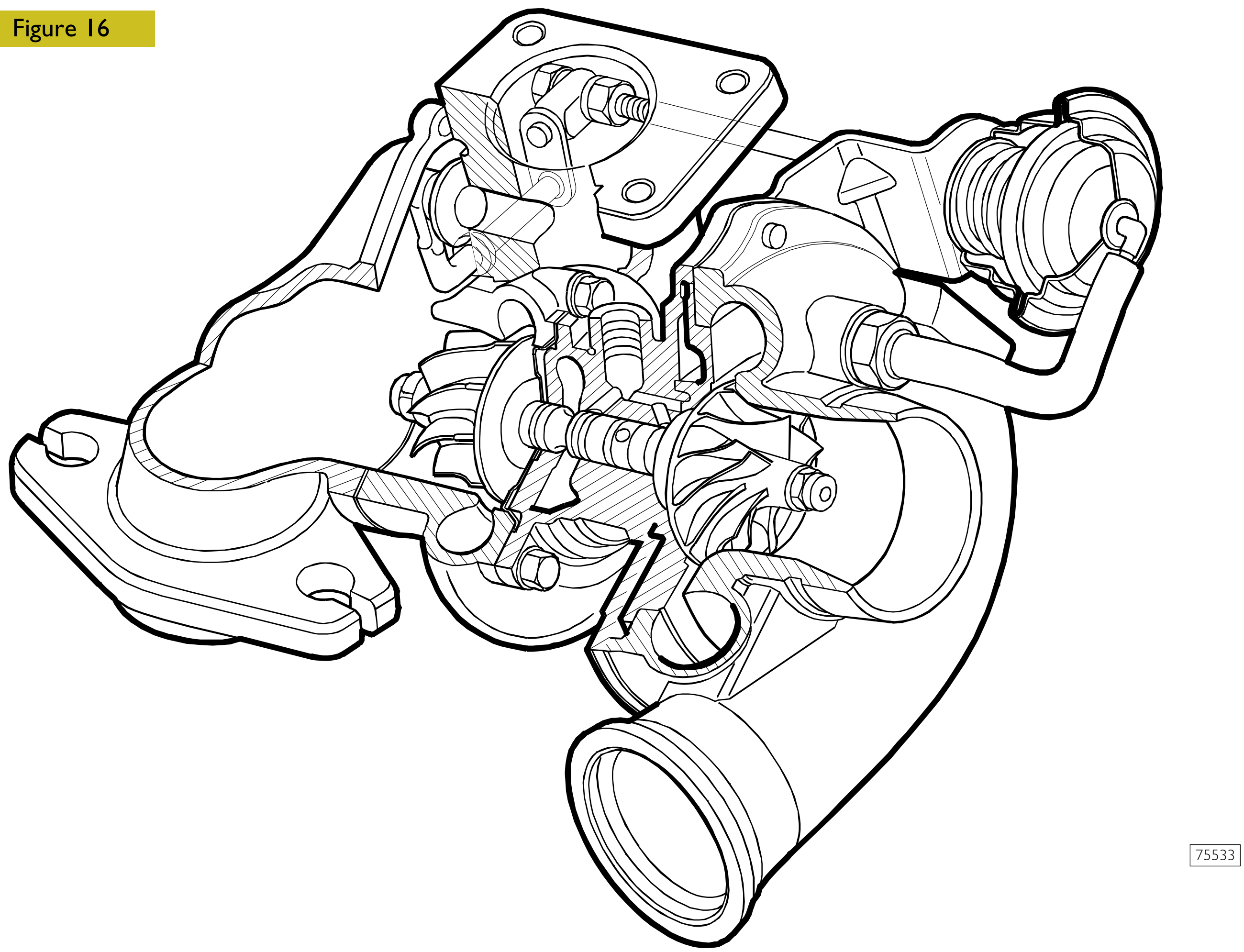
Turbocharger

Figure 15



A. THROTTLE VALVE SHUT B. THROTTLE VALVE OPEN

Figure 16

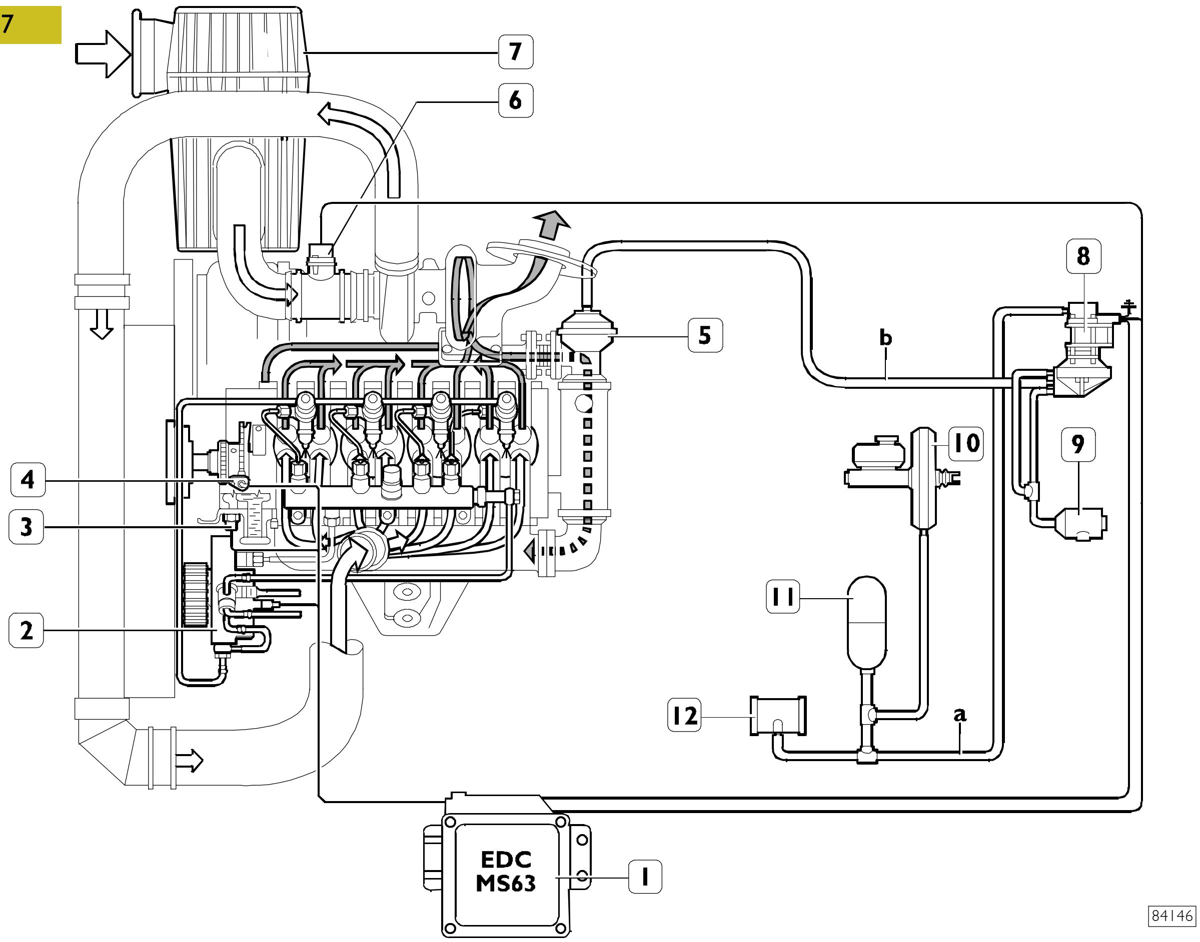


It is basically composed of:

- a central casing housing a shaft supported by bushings at whose opposite ends are fitted the turbine wheel and the compressor rotor;
- a turbine casing and a compressor casing mounted on the end of the central body;
- an overpressure relief valve fitted on the turbine casing. Its function is to choke the exhaust gas outlet (detail B), sending a portion of the exhaust gas straight into the exhaust pipe when the turbocharging pressure downstream from the turbocharger reaches the setting.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM (Illustration, if available)

Figure 17



a. Brake booster vacuum circuit - b. EGR modulated vacuum circuit
1. ECU - 2. High pressure pump - 3. Coolant temperature sensor - 4. Engine rpm sensor - 5. EGR pneumatic valve - 6. Flow meter - 7. Suction air cleaner - 8. Modulating solenoid valve - 9. Air cleaner - 10. Vacuum brake booster -11. Reservoir - 12. Vacuum unit.

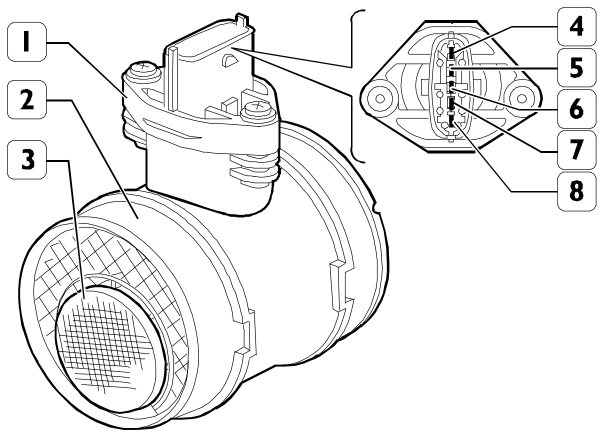
EGR system operation

The EGR system is similar to that fitted on 8140.63 engines and described in the specific system section.
Differences with respect to the previous version fitted on 8140.63 engines include: application of an exhaust gas heat exchanger and air flow meter, governing system implementing EDC MS6.3 or EDC 16, different modulating solenoid valve and pneumatic EGR calibration values.

Operating principles

The ECU (MS6.3 or EDC 16) processes the data from the atmospheric pressure sensor, coolant sensor, engine rpm sensor, accelerator pedal potentiometer and controls the modulating solenoid valve via a PWM signal according to programmed settings.
The control signal output by the ECU controls the modulating solenoid valve which puts the brake booster vacuum circuit into communication with that of the EGR. The vacuum created in the EGR circuit depends on the control signal.
The vacuum acts on the pneumatic EGR valve by recalling and lifting the shutter which normally closes the passage of exhaust gasses to suction.
This puts the exhaust manifold into communication with the suction manifold and part of the exhaust gasses flows into the intake manifold.
The control signal from the ECU to the modulating valve is cancelled during engine conditions not requiring exhaust gas recirculation (cranking, cold engine, idling, load request, high altitude). The solenoid valve closes the connection between the brake booster vacuum circuit and the EGR circuit; at the same time, atmospheric pressure is re-established in the EGR circuit by letting in air through the specific air cleaner.

Figure 18



Air flow meter

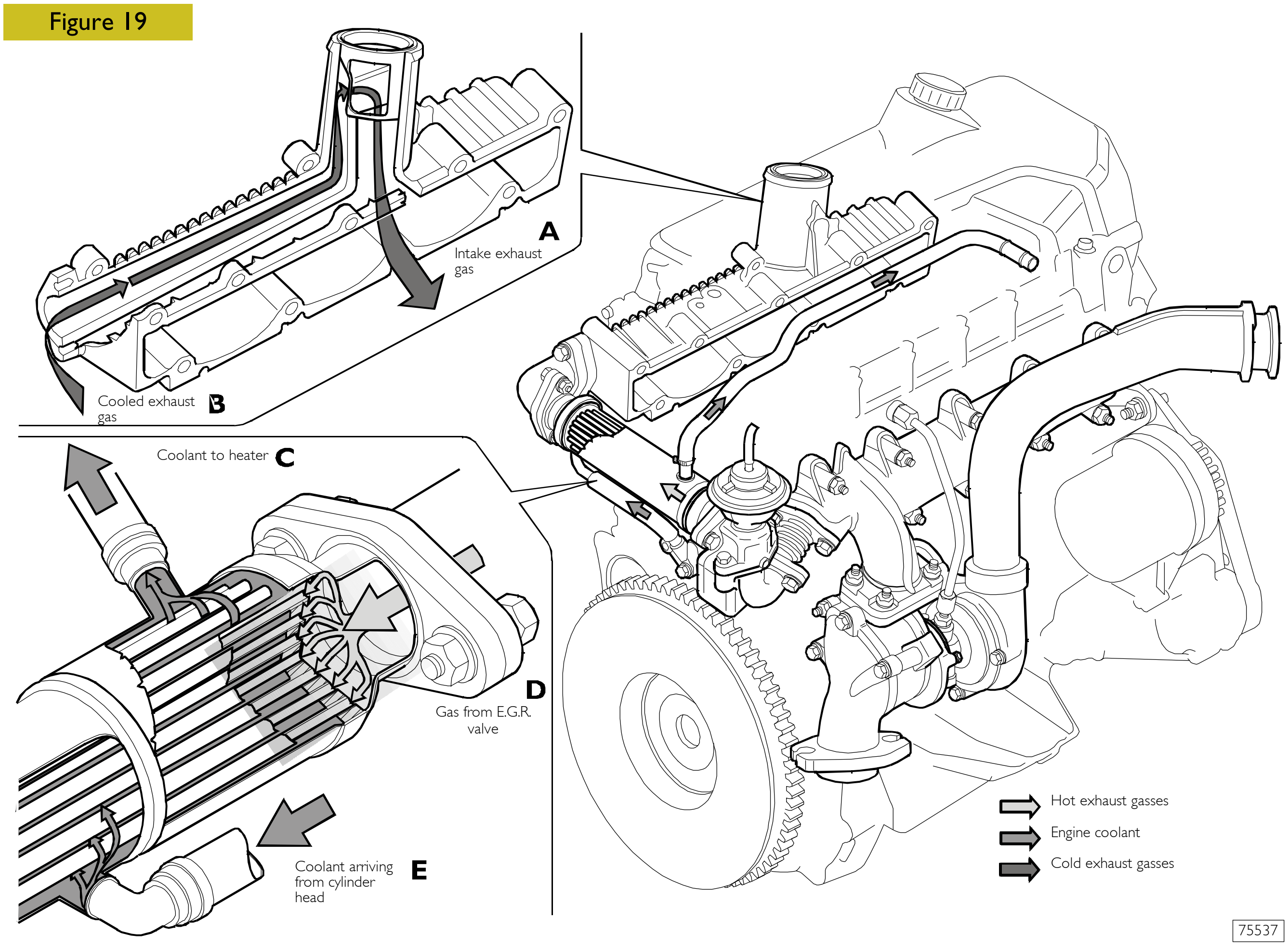
1. Connector - 2. Flow meter body - 3. Air and recirculated gas inlet mesh - 4. Suction air temperature sensor - 5. Power - 6. Ground - 7. Reference voltage - 8. Output signal.

The heated film flow meter is arranged between the turbine and the intercooler.
The suction air temperature sensor is built into the flow meter; the flow meter is connected to the ECU pins A5/A17/A18/A26/A28.

Operation

The hot film membrane temperature is kept constant (approximately 120 °C higher than suction air temperature) by a heating resistor.
The air mass crossing the duct tends to subtract heat from the membrane. Consequently more current is required through the resistor to keep the temperature constant.
Current uptake is proportional to the mass of air flowing into the engine. It is measured by a Wheatstone bridge and the resulting signal is sent to the ECU.

Figure 19



EXHAUST GAS COOLING
A. Intake exhaust gas – B. Cooled exhaust gas – C. Coolant to heater – D. Gas from E.G.R. valve – E. Coolant arriving from cylinder head.

SECTION 2

Fuel

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OPERATION

In this injection system, the pressure regulator, located upstream from the high-pressure pump, governs the flow of fuel needed in the low-pressure system. Afterwards, the high-pressure pump correctly supplies the hydraulic accumulator.

This solution, pressurizing solely the necessary fuel, improves the energy efficiency and limits heating the fuel in the system. The relief valve fitted on the high-pressure pump has the function of keeping the pressure, at the pressure regulator inlet, constant at 5 bars; irrespective of the efficiency of the fuel filter and of the system upstream. The action of the relief valve causes an increase in the flow of fuel in the high-pressure pump cooling circuit.

The high-pressure pump continually keeps the fuel at the working pressure, irrespective of the timing and the cylinder that is to receive the injection and accumulates it in a duct common to all the electro-injectors.

At the electro-injector inlet, there is therefore always fuel at the injection pressure calculated by the electronic control unit.

When the solenoid valve of an electro-injector is energized by the electronic control unit, fuel taken straight from the hydraulic accumulator gets injected into the relevant cylinder.

The hydraulic system is made out of a low-pressure fuel recirculation circuit and a high-pressure circuit.

The high-pressure circuit is composed of the following pipes:

- pipe connecting the high-pressure pump outlet to the Rail;
- hydraulic accumulator;
- pipes supplying the electro-injectors.

The low-pressure circuit is composed of the following pipes:

- fuel intake pipe from the tank to the pre-filter;
- pipes supplying the mechanical supply pump and the pre-filter;
- pipes supplying the high-pressure pump via the fuel filter.

The fuel system is completed by the fuel outlet circuit from the hydraulic accumulator and from the electro-injectors.

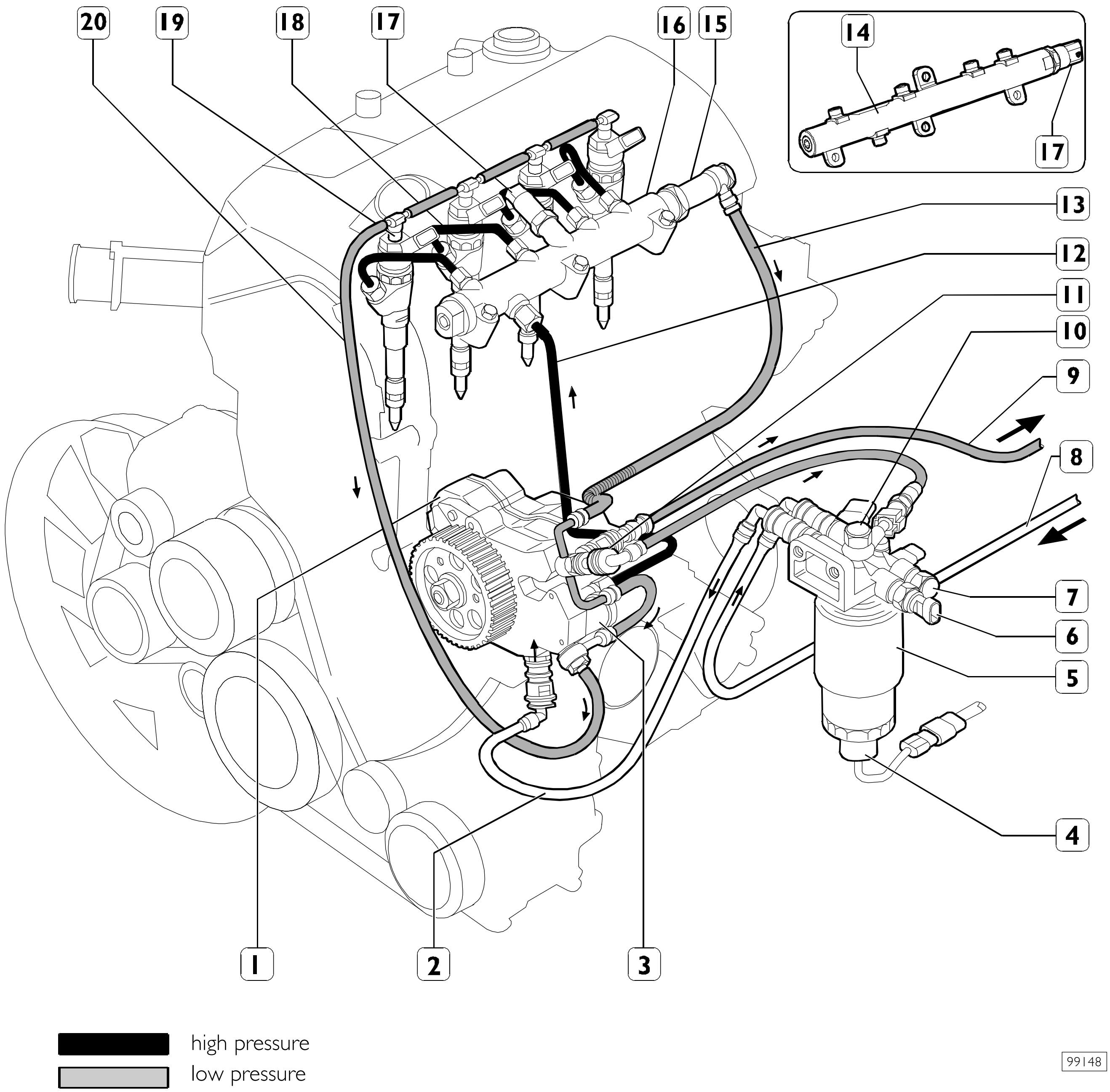
According to the high performance of this hydraulic system, for reasons of safety it is necessary to:

- avoid connecting high-pressure pipe fittings with approximate tightening;
- avoid disconnecting the high-pressure pipes with the engine running (NEVER try bleeding, which is both pointless and dangerous).

The integrity of the low-pressure circuit is also essential for the system to work properly; it is therefore necessary to avoid all manipulation and modifications and act only in the event of leakage.

NOTE The pipes connected to the fuel filter mounting are quick-coupling ones.
Before fitting them, make sure the couplings and the associated fittings on the mounting are clean.

Figure 1



FUEL RECIRCULATION AND SUPPLY SYSTEM DIAGRAM

1. CP3 high-pressure pump with integrated supply pump – 2. Fuel arrival pipe from the filter – 3. Pressure regulator – 4. Water in filter sensor – 5. Fuel filter with water separator – 6. Fuel temperature sensor – 7. Fuel warming – 8. Fuel delivery pipe to the filter – 9. Fuel return pipe to the tank – 10. Fuel check valve – 11. Multiple coupling – 12. Fuel return low pressure piping - 13. Welded version hydraulic accumulator - 14. High-pressure delivery pipe to the hydraulic accumulator – 15. Low-pressure return pipe from the hydraulic accumulator to the multiple coupling – 16. Overpressure valve – 17. Forged version hydraulic accumulator – 18. Pressure sensor – 19. High-pressure pipe between hydraulic accumulator and electro-injectors – 20. Electro-injectors – 21. Return pipe from the electro-injectors to the high-pressure pump CP3.

HYDRAULIC SYSTEM

The hydraulic system is composed of:

- tank
- pre-filter
- electric supply pump
- fuel filter
- high pressure supply pump with supply pump built inpressure regulator
- manifold (rail)
- electro-injectors
- supply pipes and fuel recirculation

Fuel pump (if provided)

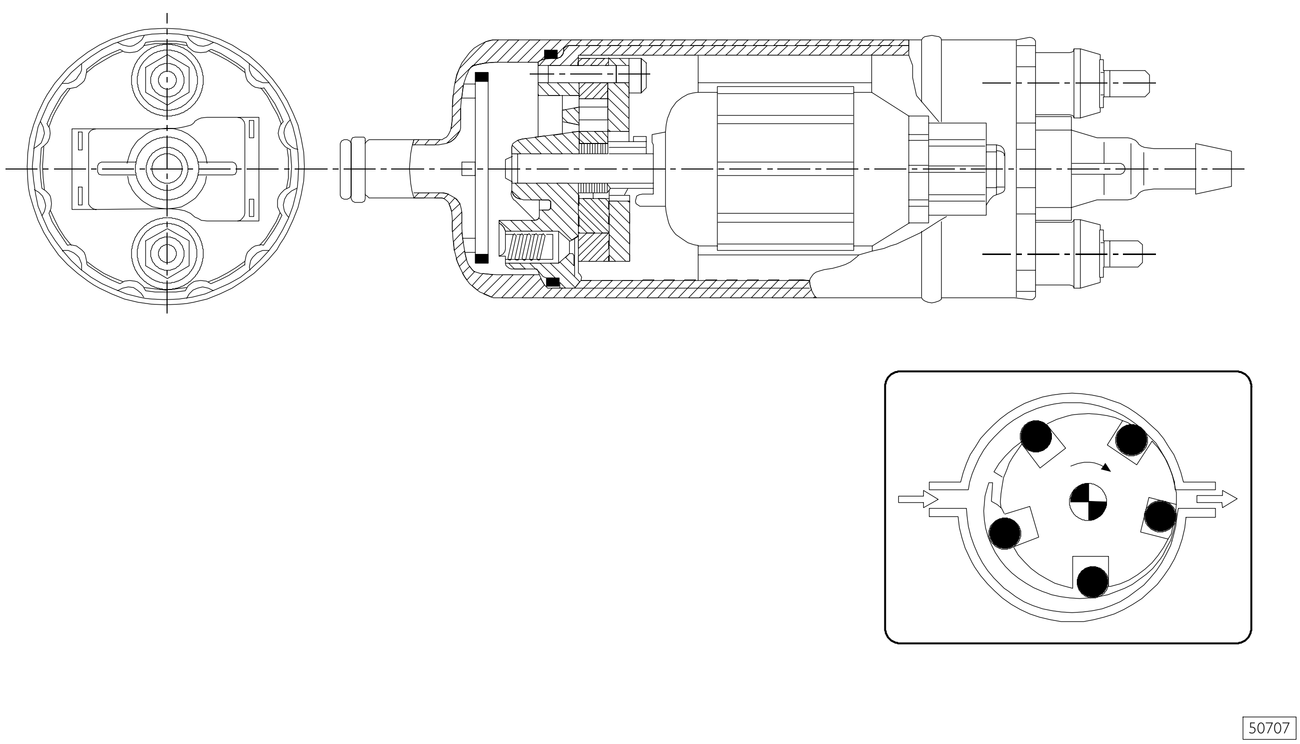
This rotary positive displacement pump with integrated by-pass is mounted on the suction pipe, on the left-hand side of the chassis frame.

The fuel pump is the roller-type with positive displacement, a brush motor with energizing by permanent magnets.
The impeller turns, driven by the motor, creating volumes that shift from the inlet port to the delivery port.
These volumes are defined by the rollers that stick to the outer ring when the motor turns.
The pump has two valves, a check valve to prevent the fuel circuit from emptying (with the pump stationary) and an overpressure valve that recirculates the delivery with the inlet when pressures over 5 bar are produced.

Specifications

Delivery pressure:	2.5 bar
Flow rate:	> 155 litres/h
Power supply:	13.5 V - < 5 A
Coil resistance at 20°C:	28.5 Ohms

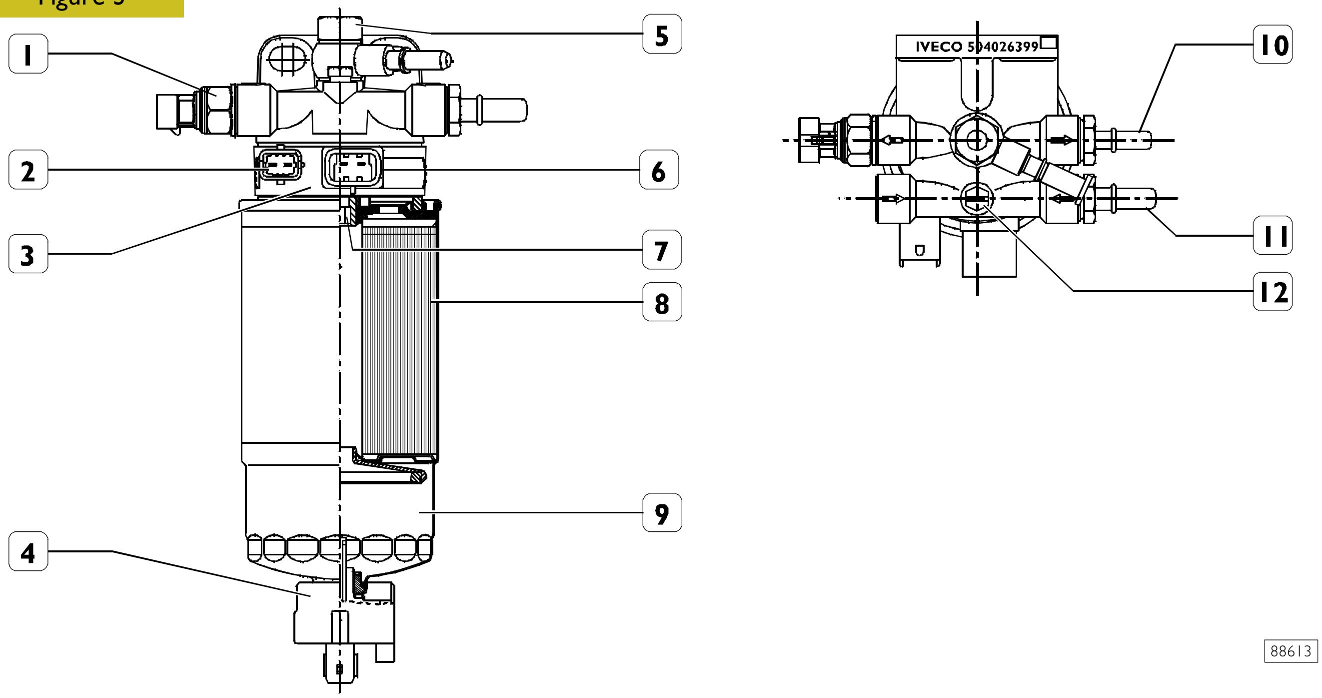
Figure 2



CROSS-SECTION OF FUEL PUMP

Fuel filter

Figure 3



1. Clogging signalling sensor - 2. Temperature sensor connector - 3. Heater support - 4. Water in signalling sensor - 5. Overpressure valve - 6. Heater connector - 7. Bending insert - 8. Fuel filter - 9. Water separator - 10. Connector - 11. Connector - 12. Purging screw.

The fuel filter is composed of a cartridge (8) equipped with a water separator (9).
The water accumulation capacity (A) of the filter is approx. 100 cm^3.
The water indicator (4) is mounted on the bottom end. Unscrewing the indicator (4) drains off any water.
Heater support (3) has an integrated temperature sensor.
On heater support (3) there are screwed up sensor (1) to signal filter clogging and non return valve (5).
When the temperature of the diesel is less than 6 °C, an electric heating element warms it up to at most 15 °C before sending it to the high pressure pump.

Check valve characteristics

opening pressure $0.5^{+0.05}_{-0.1}$ bar

differential pressure less than 0.2 bar at 120 litres/h of fuel.

Clogging indicator characteristics

differential working pressure 1.1 bar

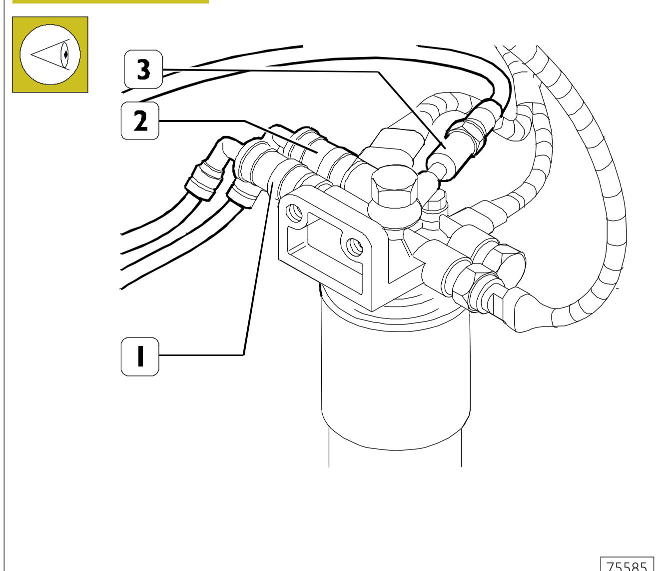
Tightening torques

1.	Tightening clogging signalling sensor	20±2 Nm
4.	Water in signalling sensor	0.8±1.2 Nm
5.	Check valve tightening	25±2 Nm
8.	Fuel filter tightening	18±2 Nm
10.	Connector	35±2 Nm
11.	Connector	35±2 Nm
12.	Bleed screw	4 Nm
7.*	Threaded insert	35±2 Nm

* Before mounting, apply thread holding down Loctite on thread.

Fuel pipes

Figure 4

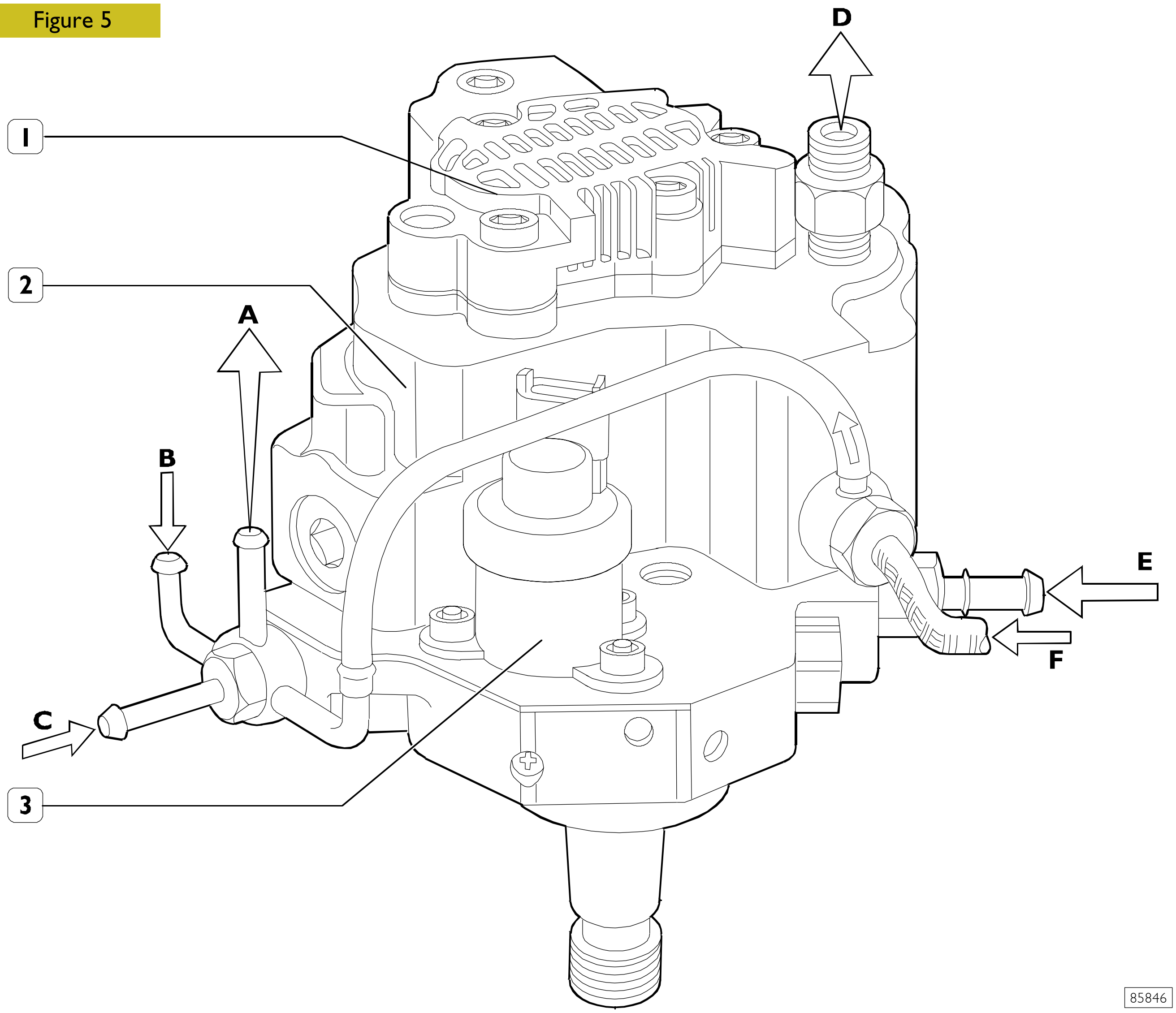


1. High-pressure pump supply pipe quick-coupling fitting – 2. Supply pipe quick-coupling fitting – 3. Fuel return pipe quick-coupling fitting – 4. Fuel filter mounting.

If disconnecting the fuel pipes (1-2-3) from the mounting (4), it is necessary, when refitting, to make sure their fittings are perfectly clean. This is to avoid an imperfect seal and fuel getting out.

High-pressure pump

Figure 5

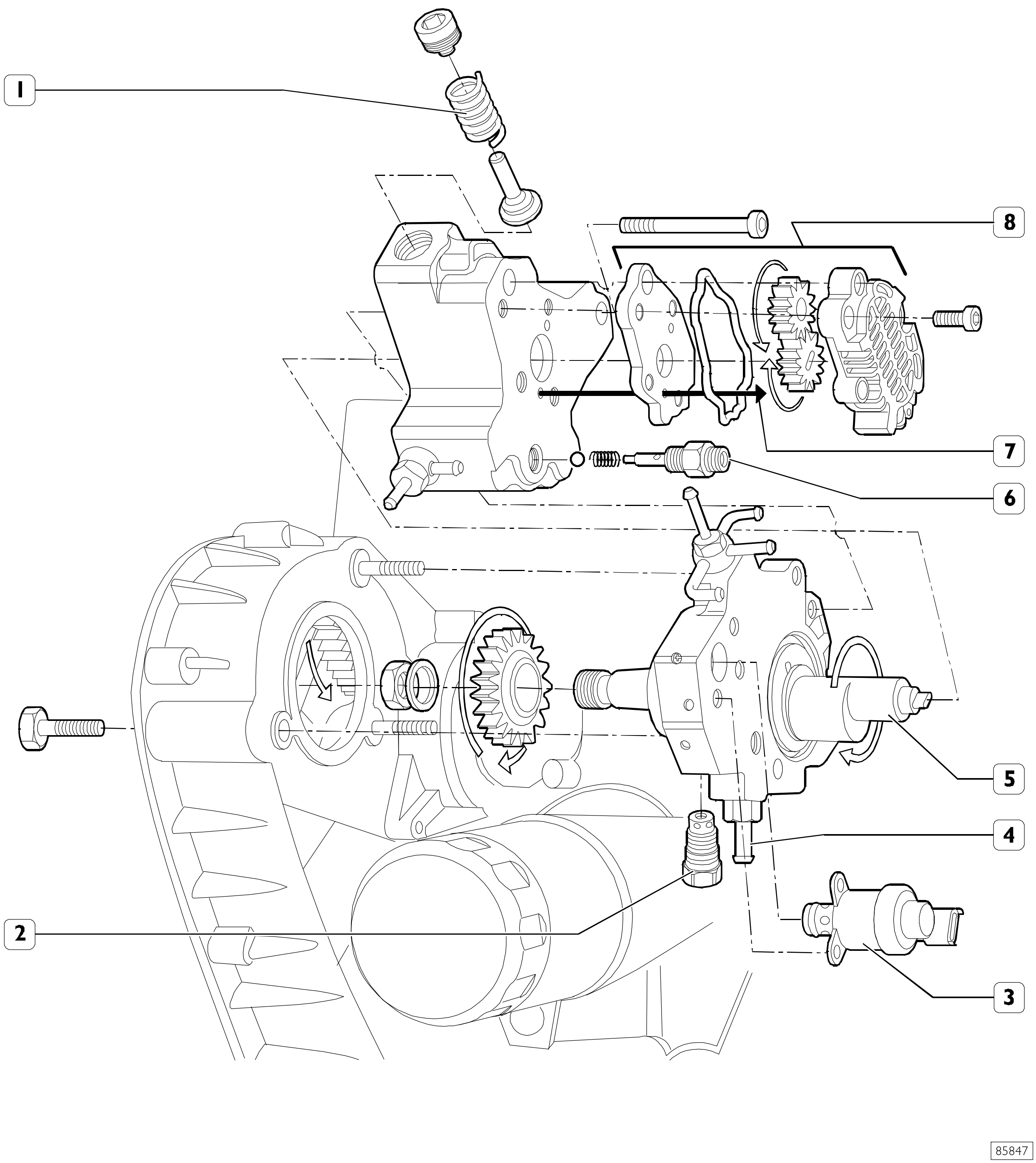


1. Mechanical feeding pump - 2. CP3 high pressure pump - 3. Pressure regulator A. To the tank - B. Return from rail - C. Return from fuel filter - D. Delivery to rail - E. From tank - F. Return to injectors.

Pump with 3 radial pumping elements controlled via a gear by the timing belt; it needs no timing. On the rear of the high-pressure pump there is the mechanical supply pump, controlled by the shaft of the high-pressure pump.
The pump is lubricated and cooled by the fuel.

NOTE The high-pressure pump – supply pump assembly cannot be overhauled and therefore the fixing screws must be neither removed nor tampered with. The only permissible job is replacing the driving gear.

Figure 6



1 Delivery valve on single pumping element – 2. Relief valve 5 bar – 3. Pressure regulator – 4. Fuel inlet from filter – 5. Pump shaft – 6. Delivery valve to common rail – 7. Fuel return from high-pressure pump – 8. Mechanical supply pump.

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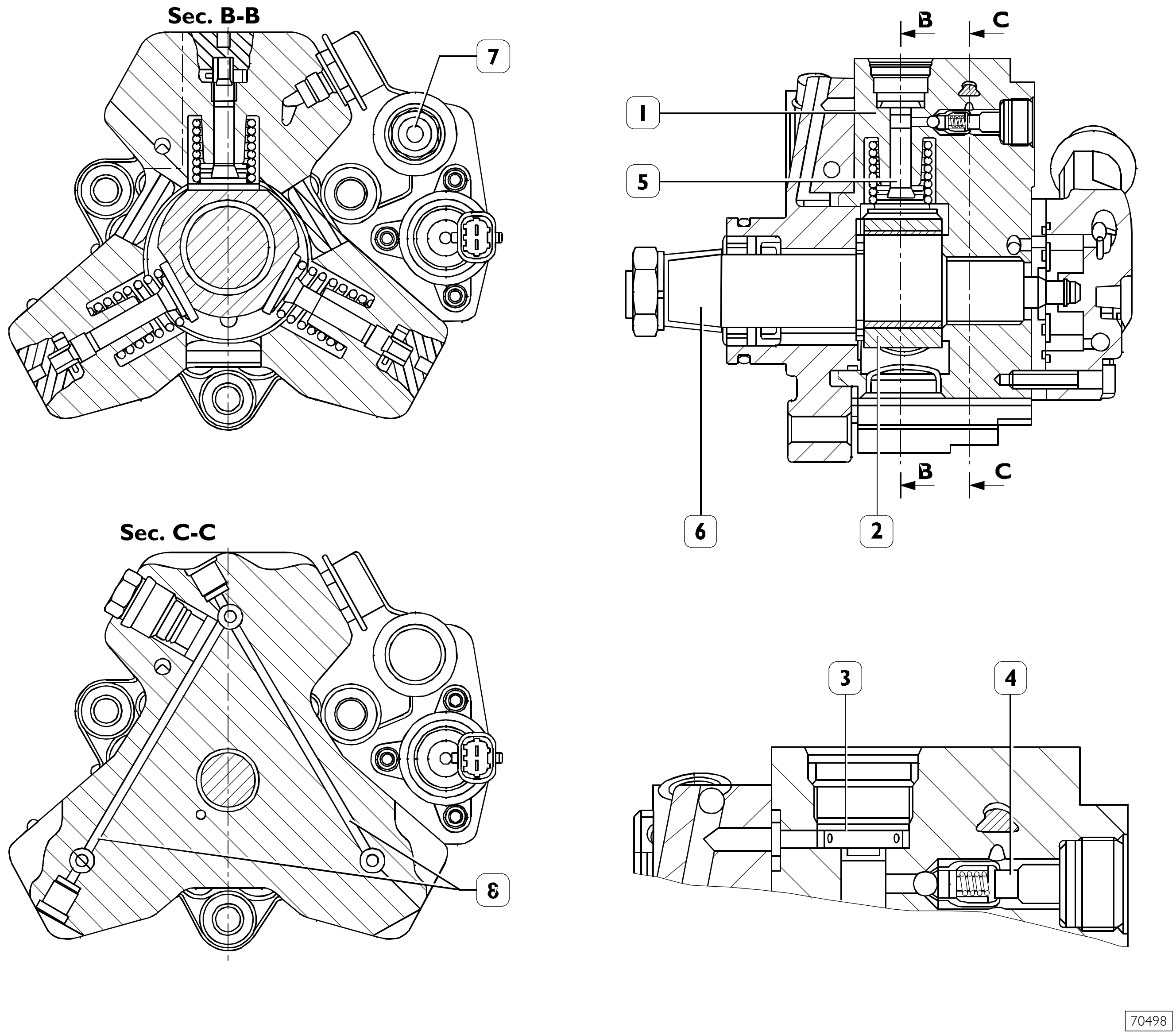
High-pressure pump internal structure

Figure 7



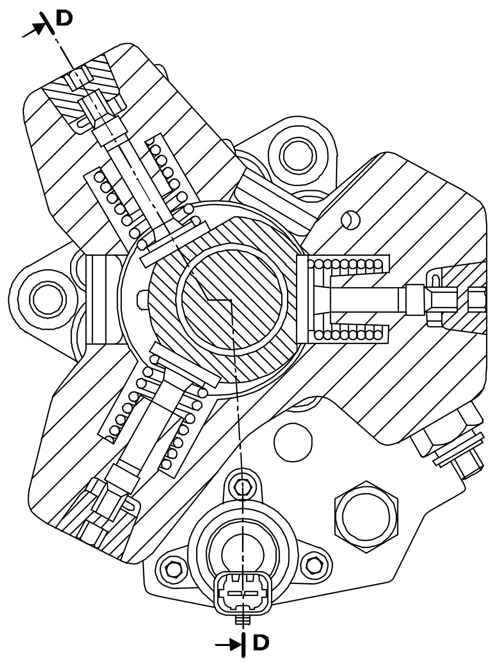
1. Cylinder – 2. Three-lobed element – 3. Plate intake valve – 4. Ball delivery valve – 5. Plunger – 6. Pump shaft – 7. Low-pressure fuel inlet – 8. Fuel ducts to supply pumping elements.

Each pumping assembly comprises:

- a plunger (5) operated by a three-lobed element (2) floating on the shaft of the pump (6). Since the element (2) floats on a misaligned portion of the shaft (6), during shaft rotation, it does not turn with it but is only shifted in a circular movement on a wider radius, with the result of working the three pumping elements alternately:
- a plate intake valve (3);
- a ball delivery valve (4).

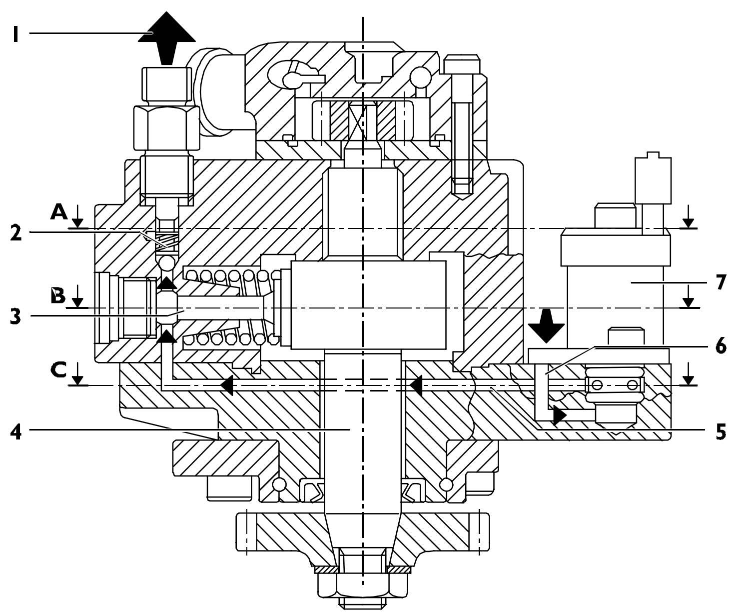
Working principle

Figure 8



Sec. B - B

Figure 9



Sec. D - D

72597

1. Outlet for delivery to rail – 2. Delivery valve to rail – 3. Pumping element – 4. Pump shaft – 5. Pumping element supply duct – 6. Pressure regulator supply duct – 7. Pressure regulator.

The pumping element (3) is arranged on the cam on the pump shaft. In the suction phase, the pumping element is supplied through the supply duct (5). The amount of fuel to send to the pumping element is determined by the pressure regulator (7). The pressure regulator, on the basis of the PWM command received from the control unit, chokes the flow of fuel to the pumping element. During the compression phase of the pumping element, the fuel, on reaching such a pressure as to open the delivery valve to the common rail (2), supplies it through the outlet (1).

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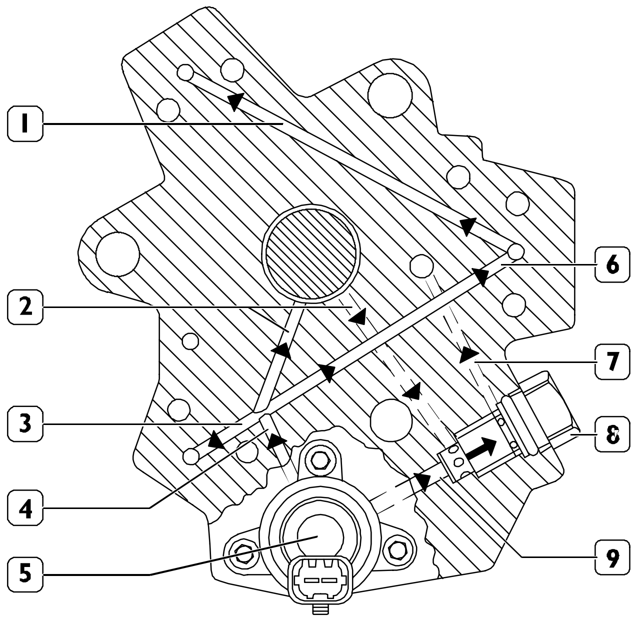
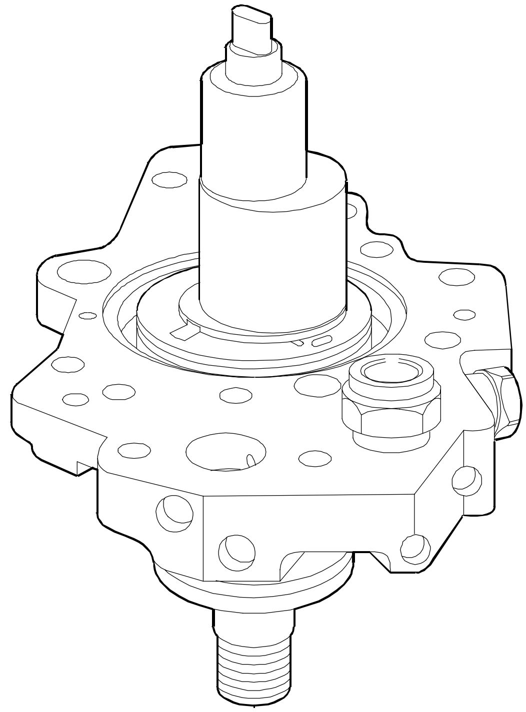
Figure 10



Sec. C – C (Figure 9)

72598



72599

1, 3, 6 Pumping element inlet – 2. Pump lubrication ducts – 4. Main pumping element supply duct – 5. Pressure regulator – 7. Regulator outlet duct – 8. Relief valve 5 bar – 9. Fuel outlet from regulator inlet.

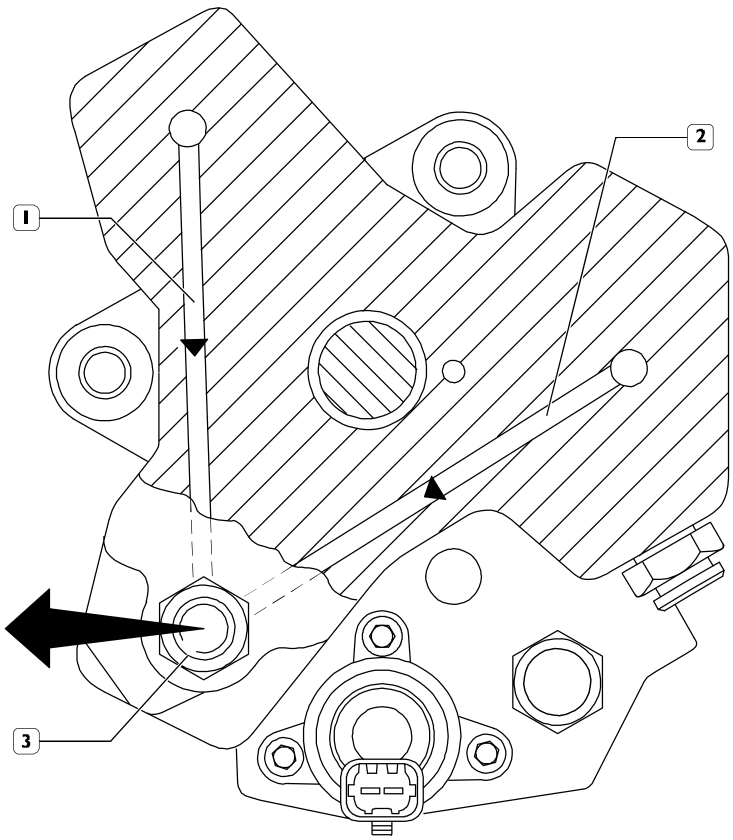
Figure 10 shows the low-pressure fuel routing in the pump; it highlights the main supply duct of the pumping elements (4), the supply ducts of the pumping elements (1-3-6), the ducts used to lubricate the pump (2), the pressure regulator (5), the 5-bar relief valve (8) and the fuel outlet.

The pump shaft is lubricated by the fuel through the delivery and return ducts (2).

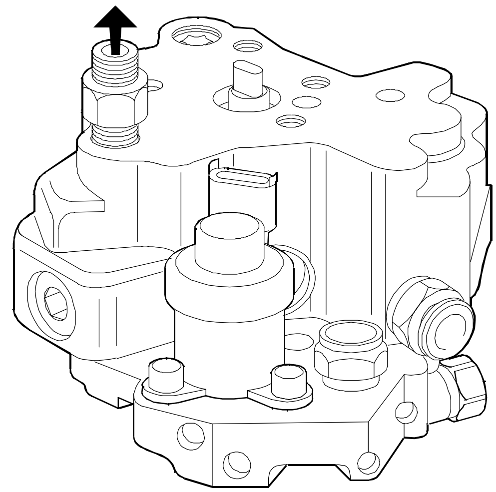
The pressure regulator (5) determines the amount of fuel with which to supply the pumping elements; excess fuel flows out through the duct (9).

The 5-bar relief valve, besides acting as a manifold for the fuel outlets, has the function of keeping the pressure constant at 5 bars at the regulator inlet.

Figure 11



72601



72600

Sec. A – A (Figure 9)

1, 2 Fuel outlet ducts – 3. Fuel outlet from the pump with coupling for high-pressure pipe for the common rail.

The Figure 11 shows the high-pressure fuel flow through the outlet ducts of the pumping elements.

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Pressure control valve

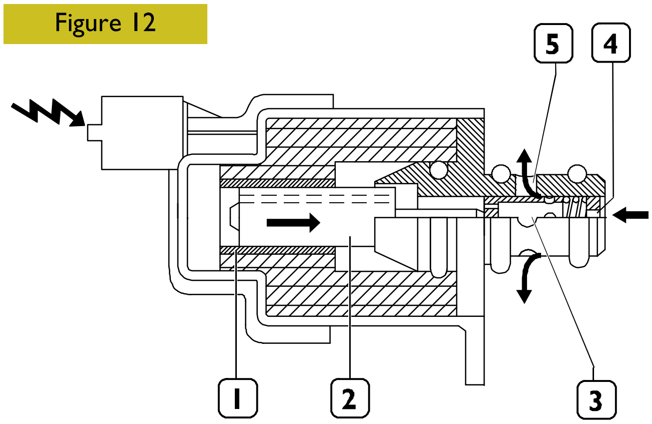
The fuel pressure regulator is mounted on the low-pressure circuit of the CP3 pump. The pressure regulator modulates the amount of fuel sent to the high-pressure circuit according to the commands received directly from the engine control unit. The pressure regulator is mainly composed of the following components:

- connector
- casing
- solenoid
- pre-load spring
- shutter cylinder.

When there is no signal, the pressure regulator is normally open, therefore with the pump providing maximum delivery. The engine control unit, via the PWM (Pulse Width Modulation) signal, modulates the change in fuel flow rate in the high-pressure circuit by partially closing or opening the sections of passage of the fuel in the low-pressure circuit.

Operation

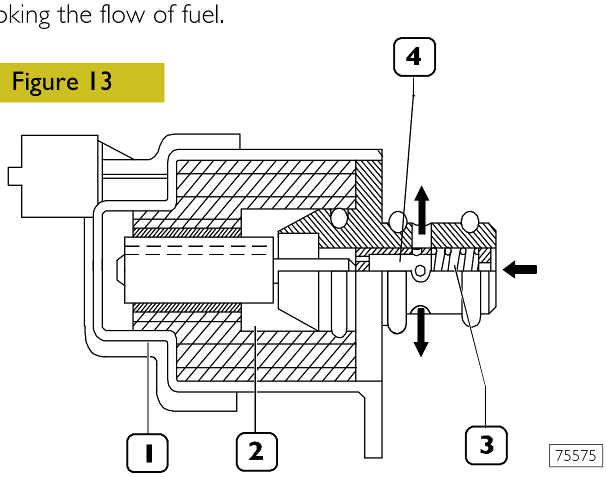
Figure 12



1. Solenoid – 2. Magnetic core – 3. Shutter cylinder – 4. Fuel inlet – 5. Fuel outlet.

When the engine control unit governs the pressure regulator (via PWM signal), the solenoid (1) is energized that, in its turn, generates the movement of the magnetic core (2). The shift of the core causes the shutter cylinder (3) to move axially, choking the flow of fuel.

Figure 13



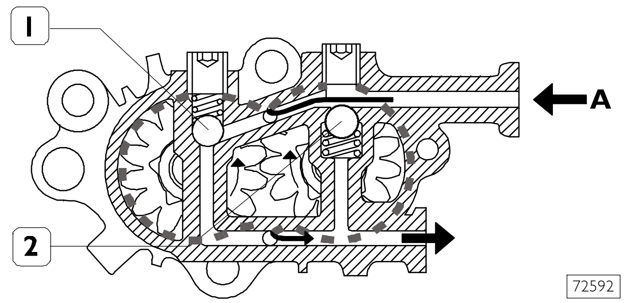
1. Solenoid – 2. Magnetic core – 3. Pre-load spring – 4. Shutter cylinder.

When the solenoid (1) is not energized, the magnetic core is pushed into the rest position by the pre-load spring (3). In this condition, the shutter cylinder (4) is in such a position as to offer the fuel the greatest section of passage.

MECHANICAL SUPPLY PUMP

Normal working condition

Figure 14

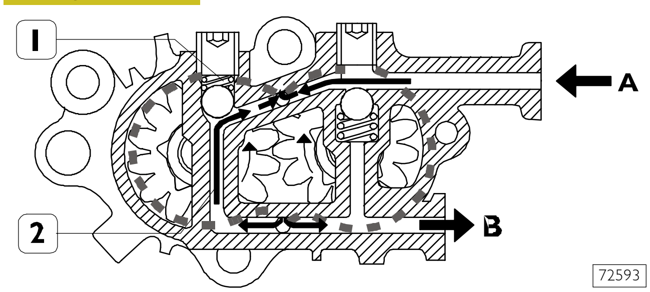


A. Fuel inlet from the tank – B. Fuel outlet to the filter – 1, 2 By-pass valves in closed position.

The function of the gear pump, mounted on the rear of the high-pressure pump, is to supply the high-pressure pump. It is governed by the shaft of the high-pressure pump.
In normal working conditions, the flow of fuel inside the mechanical pump is shown in the figure.

Conditions of outlet overpressure

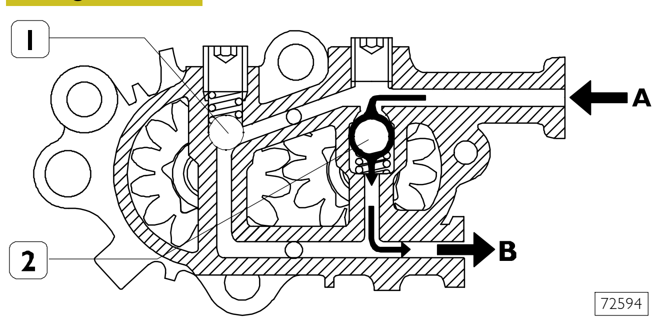
Figure 15



The by-pass valve (1) trips when overpressure is generated at the outlet B. The pressure, overcoming the elastic resistance of the spring of the valve (1), sets the outlet in communication with the inlet via the duct (2).

Conditions of bleeding

Figure 16



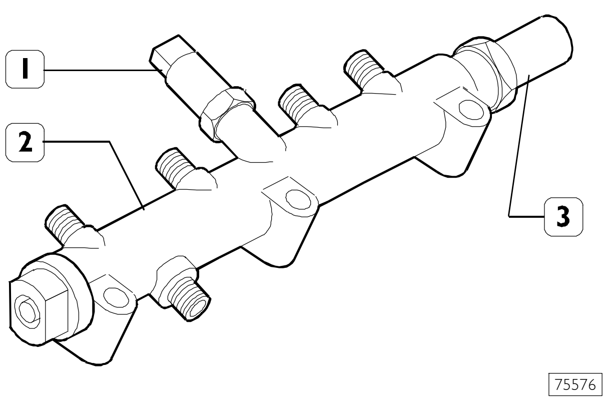
The by-pass valve (1) trips when, with the engine switched off, you want to fill the supply system via the priming pump. In this situation, the by-pass valve (2) opens, due to the effect of the inlet pressure, and the fuel flows out via the outlet B.

Hydraulic accumulator (rail)

The hydraulic accumulator is mounted on aspiration side cylinder head.
Its task is to damp pressure oscillations caused:

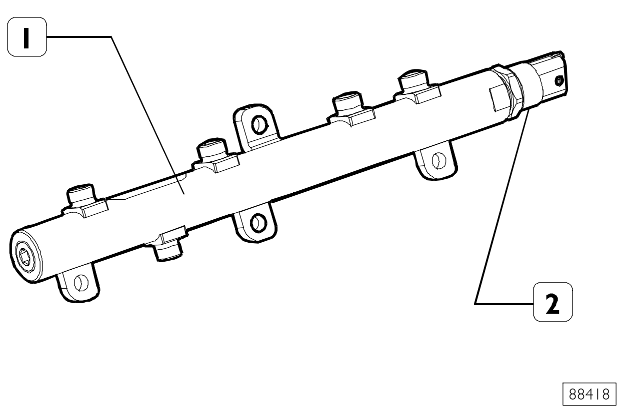
- the operation of the high-pressure pump;
- the opening of the electro-injectors.

Figure 17



1. Forged version hydraulic accumulator, inner volume ~ 22 cm^3 - 2. Fuel pressure sensor - 3. Overpressure valve.

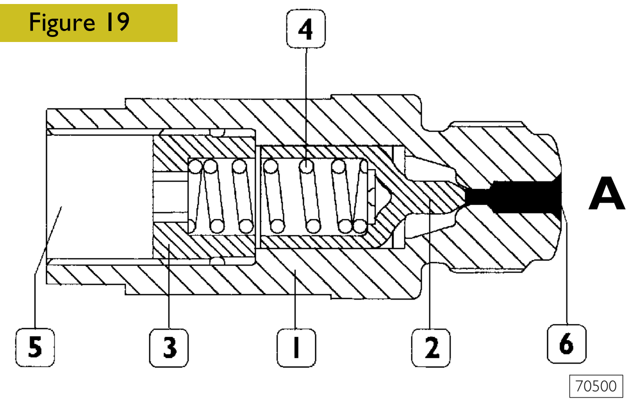
Figure 18



1. Welded version hydraulic accumulator, inner volume ~ 23 cm^3 - 2. Fuel pressure sensor.

Overpressure valve (for forged hydraulic accumulator)

Figure 19

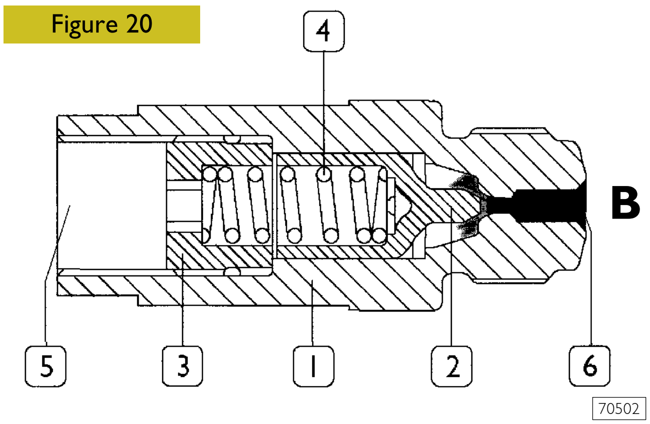


1. Casing – 2. Plunger – 3. Stop – 4. Spring – 5. Direct outlet to tank – 6. Seat on rail.

The pressure relief valve protects the system components if the fuel pressure exceeds the setting: 1750 bars.

A. The tapered end of the plunger normally keeps the outlet to the tank shut.

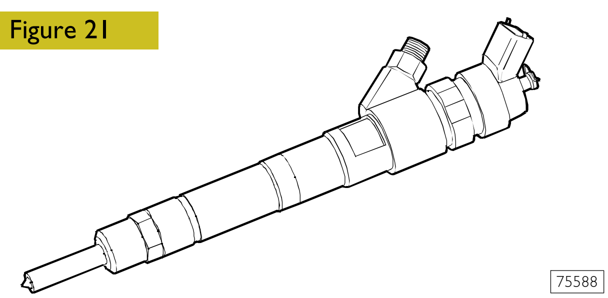
Figure 20



B. If the pressure of the fuel in the hydraulic accumulator exceeds 1750 bars, the plunger gets shifted and the excess pressure is discharged into the tank.

ELECTRO-INJECTORS

Figure 21



The electro-injectors have high-pressure supply (up to 1600 bar) and recirculation at atmospheric pressure, necessary for the diesel used to operate the pilot valve.
The temperature of the diesel put back into circulation by the electro-injector can get very high (approximately 120°C).
The head of the electro-injector has a fitting for the electrical connector.
They are mounted on the cylinder head and operated by the injection control unit.

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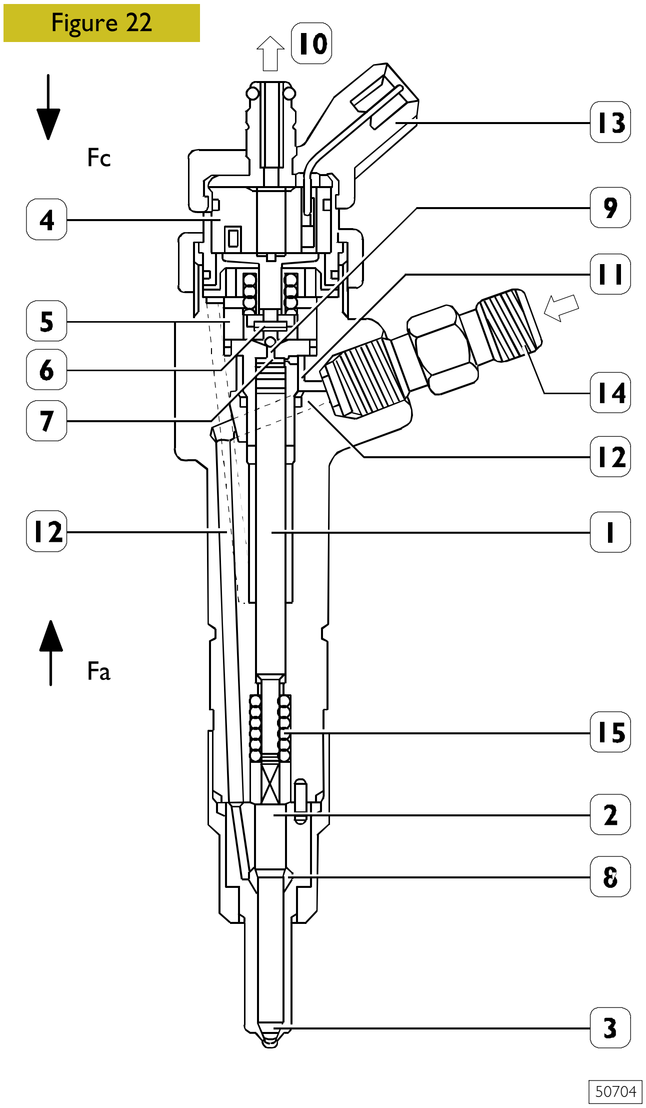
Figure 22



1 Pressure rod – 2 Pin – 3 Nozzle – 4 Coil – 5 Pilot valve – 6 Ball shutter – 7 Control area – 8. Pressure chamber – 9 Control volume – 10 Low-pressure fuel return – 11 Control pipe – 12 Supply pipe – 13 Electrical connection – 14 High-pressure fuel inlet fitting – 15 Spring.

The electro-injector can be divided into two parts:

- actuator/jet composed of pressure rod (1), pin (2) and nozzle (3);
- control solenoid valve composed of coil (4) and pilot valve (5).

Operation

Electro-injector operation can be broken down into three phases:

- "rest position"

Coil (4) is de-energised, and shutter (6) is in closing position and prevents fuel from being introduced into the cylinder, Fc > Fa (Fc: caused by fuel pressure acting on control area (7) of rod (1); Fa: caused by line pressure acting on pressure chamber (8).

- "start of injection"

The coil (4) is energized and causes the shutter (6) to rise. The fuel of the control volume (9) flows off towards the return manifold (10) causing a drop in pressure in the control area (7).
At the same time, line pressure through feed duct (12) applies a force Fa > Fc in pressure chamber (8) lifting peg (2), with fuel being consequently introduced into cylinders.

- "end of injection"

The coil (4) is de-energized and makes the shutter (6) return to its closed position. This recreates such a balance in the forces as to make the pin (2) return to its closed position and consequently end injection.

SECTION 3

Vehicle uses

Page

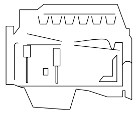
GENERAL SPECIFICATIONS

Type		F1AE0481A*....	F1AE0481B*....
ϱ Compression ratio		18	
Maximum power	kW (HP)	71 (96)	85 (116)
	rpm	3000 ÷ 3700	3000 ÷ 3900
Maximum torque	kW (HP)	240 (24.4)	270 (27.5)
	rpm	1800 ÷ 2800	1800 ÷ 2800
Slow running of engine with no load	rpm	800	
Fast idling speed of engine with no load	rpm	4600	
Pressure at T.D.C.	*bar	20 ÷ 26	
Minimum permissible pressure at T.D.C.	*bar	16	
Bore x stroke	mm	88 x 94	
Displacement	cm^3	2300	
TURBOCHARGING		With intercooler	
Turbocharger type		KKK K03-2072-EDC 5.68	
Turbocharger shaft radial play		-	
Turbocharger shaft end float		-	
Maximum stroke of pressure relief valve opening	mm	3.5 ±0.5	
Pressure corresponding to maximum stroke:	bar	1.5 ±0.002	
LUBRICATION		forced by gear pump, pressure relief valve, oil filter with integral cartridge with total filtering	
Oil pressure with engine hot (100°C ±5°C):			
at idling speed	bar	≥0.6	
at top speed	bar	4	
COOLING		by centrifugal pump, thermostat for adjustment, coolant temperature, fan with electromagnetic coupling, radiator, heat exchanger	
Water pump control:		by belt	
Thermostat:		N. I.	
start of opening:		82 ±2 °C	

(*) The pressure is measured by setting the engine turning with the aid of just the starter motor, with an oil temperature of 40 – 50°C.

⚠ Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

	Type		F1AE0481A*....	F1AE0481B*....
	FLUIDS			
	Capacity:			
	engine sump			
	at minimum level	liters	3	
		kg	2.65	
	engine sump			
	at maximum level	litres	4.3	
Urania Daily Urania LD 5		kg	3.78	
	quantity in circulation in cartridge filter and heat exchanger			
		litres	1.4	
		kg	1.23	
	quantity of oil for first filling	liters	5.7	
		kg	5.02	

Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

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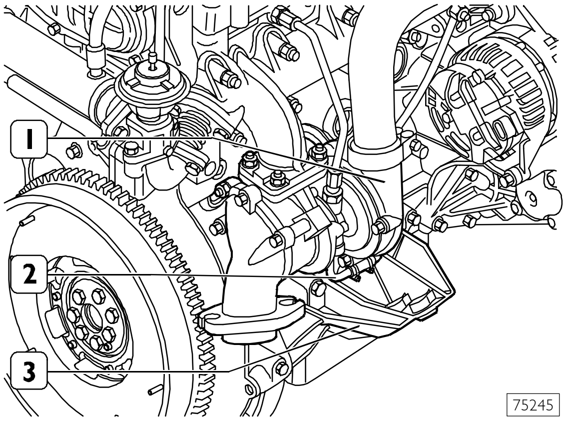
PART ONE - MECHANICAL COMPONENTS

OVERHAULING ENGINE F1A DISASSEMBLING THE ENGINE AT THE BENCH

Figure 1



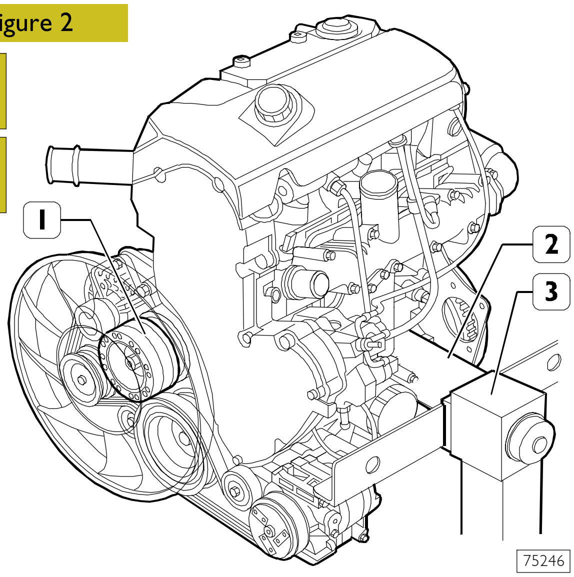
If the following parts have not already been removed, do so now:

- top soundproofing cover;
- rail guard;
- engine cable, disconnecting its electrical connections from: thermostat temperature sensor, timing sensor, engine speed sensor, pressure regulator, rail pressure sensor, intake manifold air temperature/pressure sensor.

To be able to fit the brackets 99361038 onto the crankcase to secure the engine to the stand for overhauling, it is necessary to remove the left and right engine mounts (3) and disconnect the oil pipe (2) from the turbocharger (1) and from the crankcase.

NOTE Block the turbocharger air/exhaust gas inlets and outlets to prevent foreign bodies getting inside.

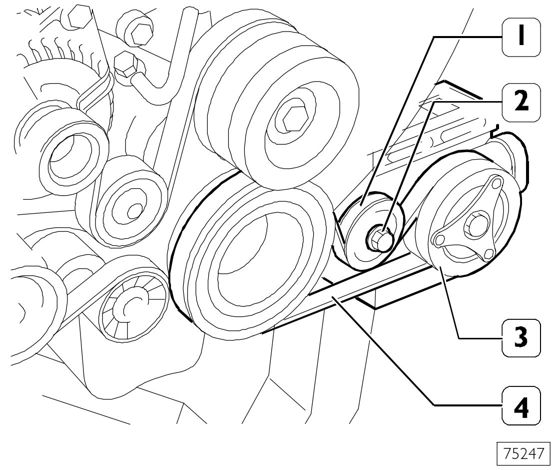
Figure 2



Fit the brackets 99361038 (2) to the crankcase and use these to secure the engine to the rotary stand 99322205 (3). Drain the oil from the engine by removing the plug from the oil sump.

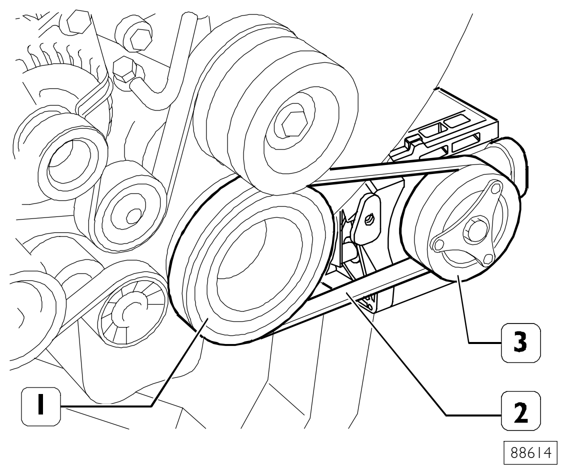
Disconnect the fan from the electromagnetic coupling (1).

Figure 3



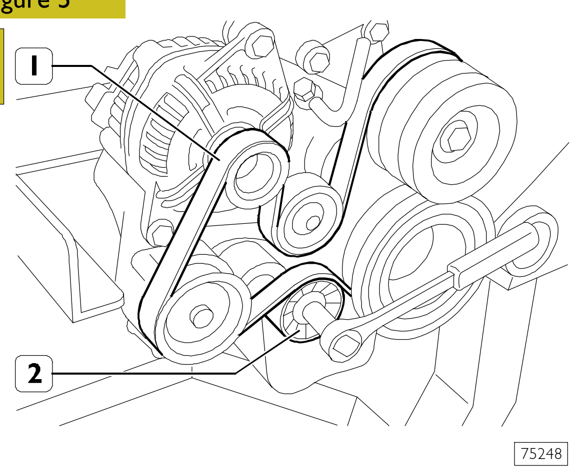
Take off screw (2), if present, and dismount belt tensioner (1). Take off the belt (4) driving the air-conditioner compressor (3).

Figure 4



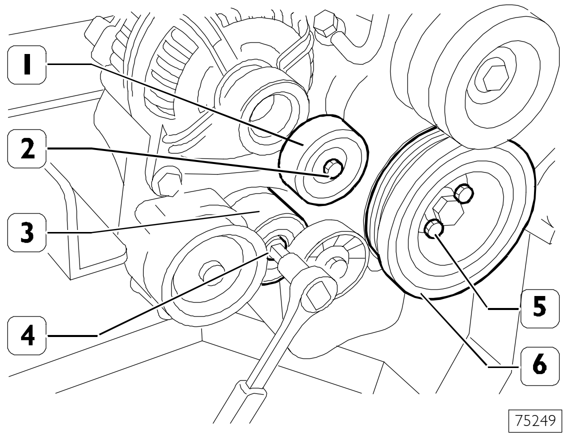
Or, on the engines with elastic belt (2), with a suitable tool, take the belt off pulleys (1 and 3).

Figure 5



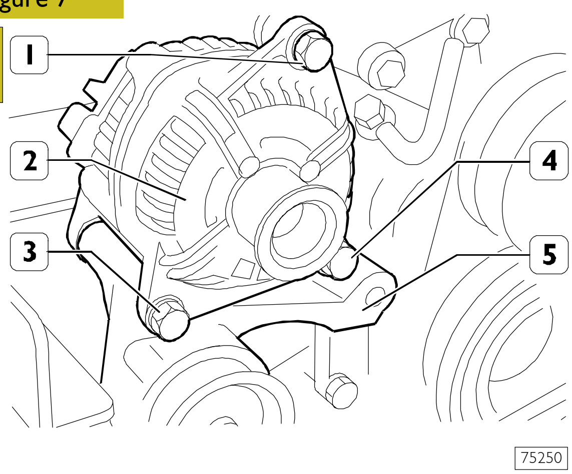
Using the specific wrench on the automatic tightener (2), slacken the tension of the belt (1) and remove it.

Figure 6



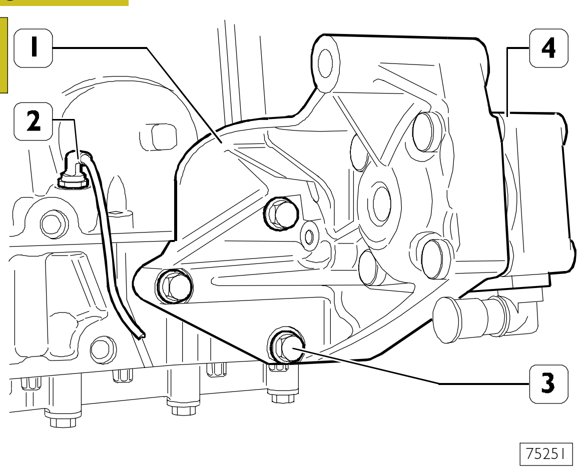
Take out the screw (4) and remove the automatic tightener (3). Take out the screw (2) and remove the fixed tightener (1). Take out the screws (5) and remove the pulley (6).

Figure 7



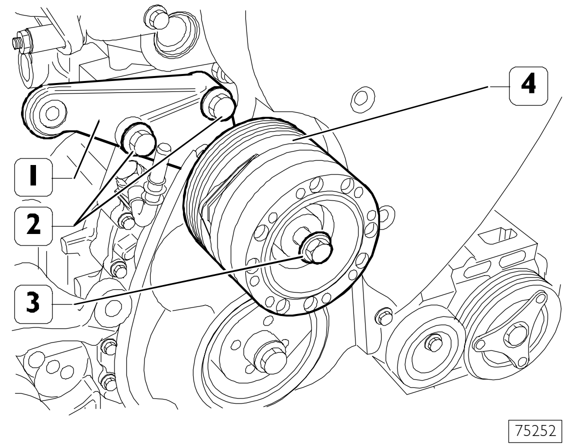
Take out the bolt (1), the bottom screws (3 and 4) and remove the alternator (2) from the mounting (5).

Figure 8



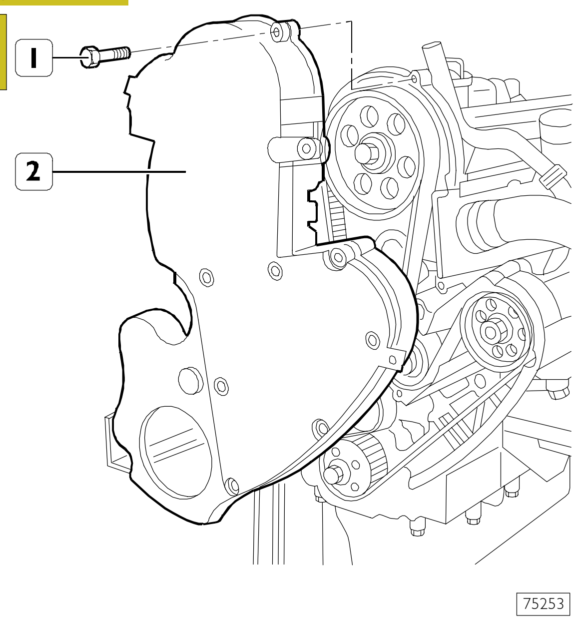
Take out the screw (3) and remove the mounting (1) of the power steering pump (4). Using a suitable wrench, remove the oil level sensor (2).

Figure 9



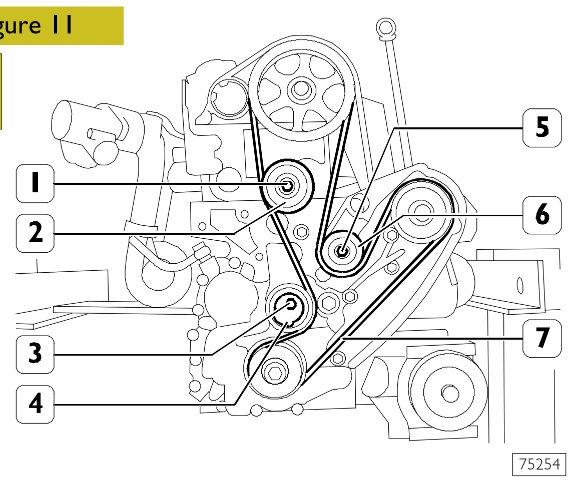
Take out the screws (2) and (3) and remove the mounting (1) together with the electromagnetic coupling (4).

Figure 10



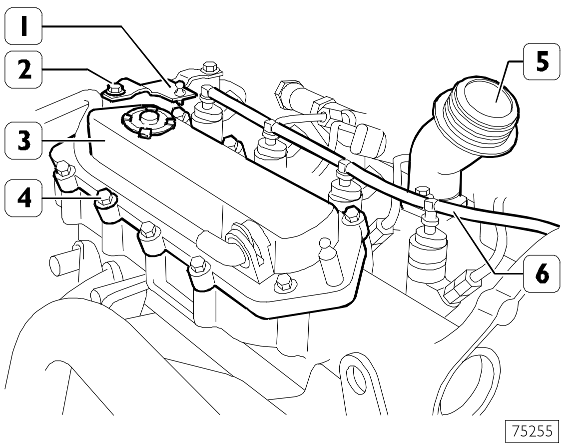
Take out the screws (1) and remove the timing cover (2).

Figure 11



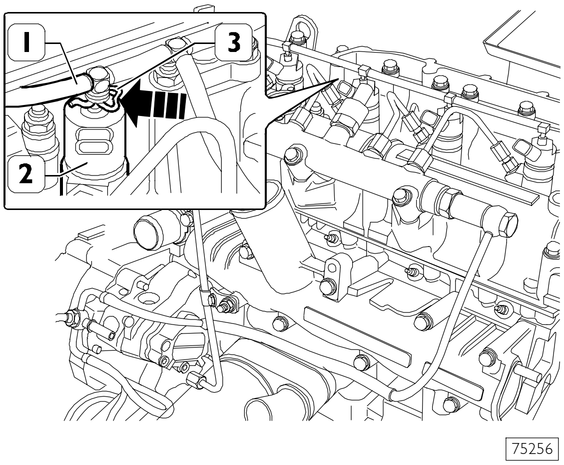
Take out the screw (3) and remove the tightener (4). Take out the screws (1) and (5) and remove the gears (2) and (6). Remove the toothed belt (7).

Figure 12



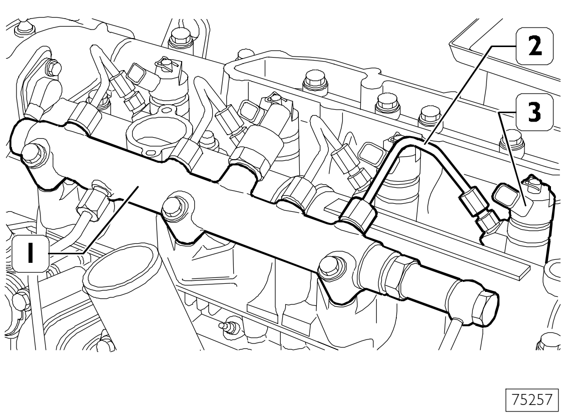
Take out the screws (2) and remove the bracket (1). Take out the screws (4) and remove the coalescence filter (3). Take off the nuts (6) and remove the oil fillpipe (5).

Figure 13



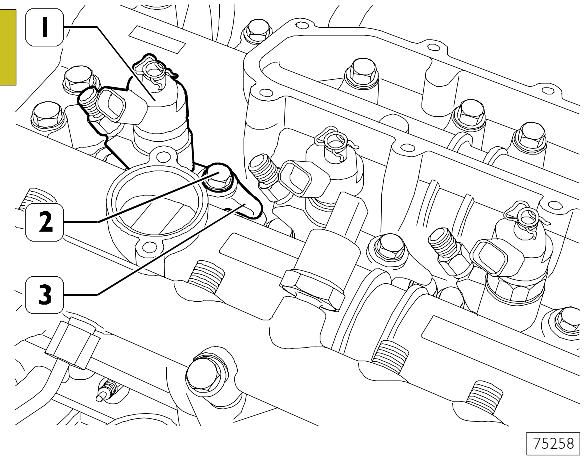
Press the springs (3) in the direction shown by the arrow and disconnect the fittings of the pipe (1) recovering fuel from the electro-injectors (2).

Figure 14



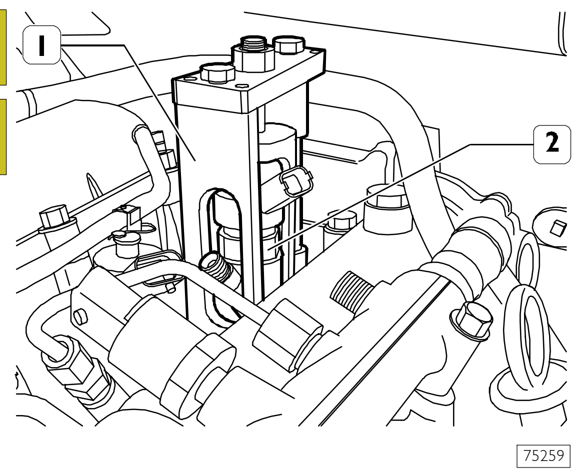
Disconnect the fuel pipes (2) from the electro-injectors (3) and from the hydraulic accumulator (1) (rail).

Figure 15



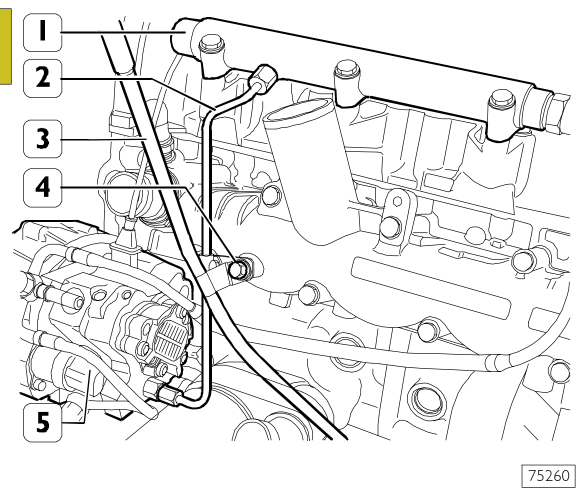
Take out the screws (2) and the brackets (3) fixing the electro-injectors (1) to the cylinder overhead.

Figure 16



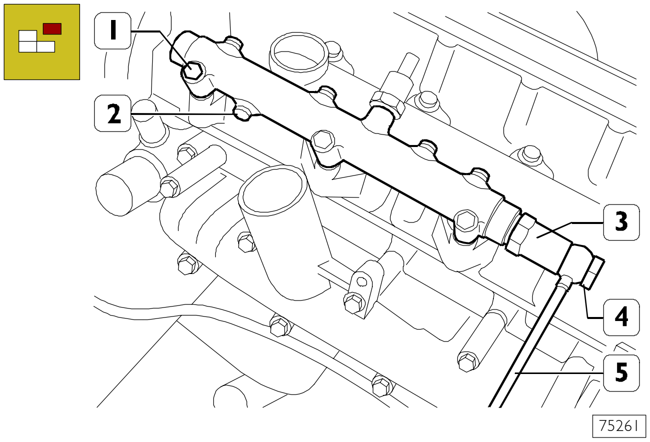
Using tool 99342153 (1) extract the electro-injectors (2) from the overhead.

Figure 17



Take out the screw (4) and extract the oil dipstick pipe (3) from the crankcase. Disconnect the pipe (2) from the hydraulic accumulator (1) and from the high-pressure pump (5).

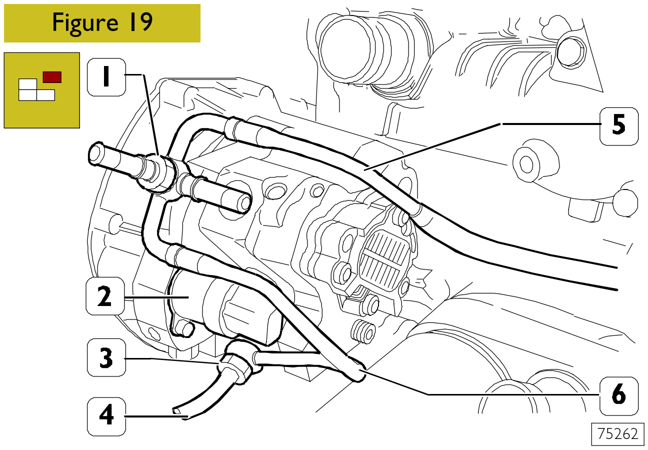
Figure 18



Only for forged version hydraulic accumulator, take off pipe fitting (4) and disconnect piping (5) for fuel recovery from overpressure valve (3).

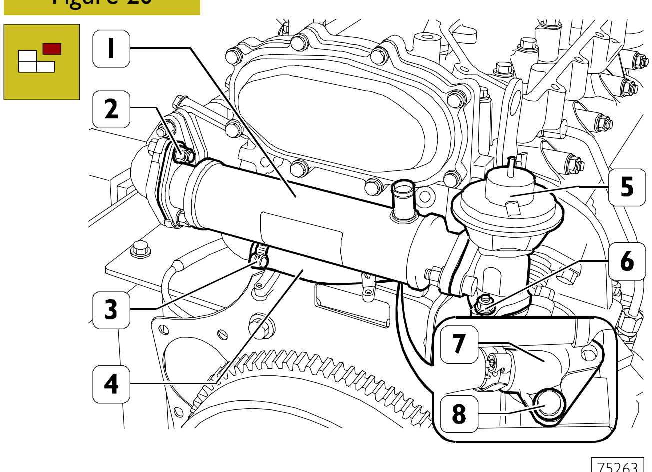
Take out the screws (1) and remove the hydraulic accumulator (2).

Figure 19



Disconnect the fuel recovery pipes (4), (5) and (6) from the high-pressure pump (2), removing the couplings (1) and (3).

Figure 20



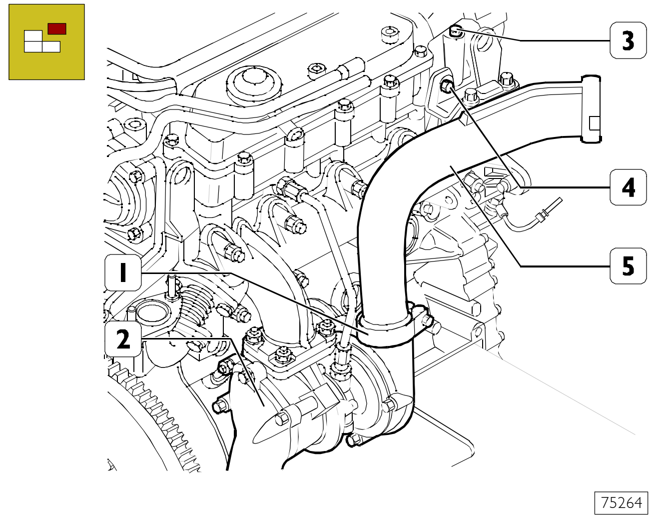
For engines with E.G.R. only (if present)

Loosen the clamp (3) and disconnect the pipe (4) from the heat exchanger (1).

Take off the nuts (2) and (6) and remove the heat exchanger (1) together with the E.G.R. valve (5).

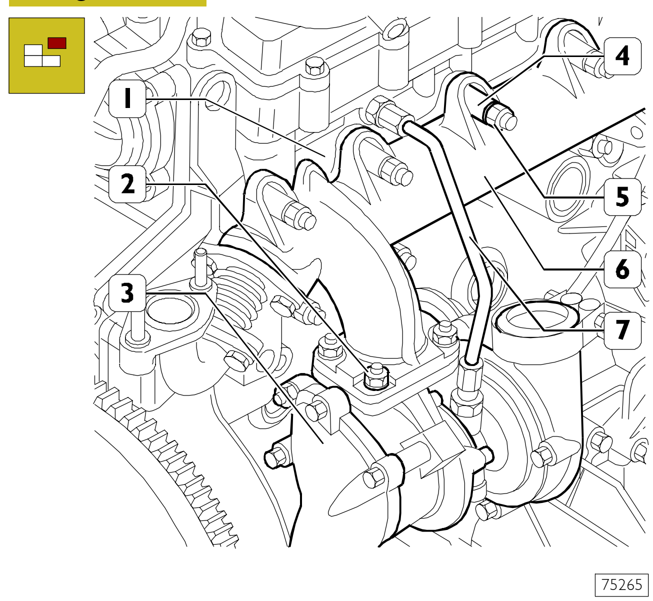
Take out the screws (8) and remove the flange (7).

Figure 21



Take out the screw (4), loosen the clamp (1) and disconnect the air duct (5) from the turbocharger (2) and from the overhead (3).

Figure 22

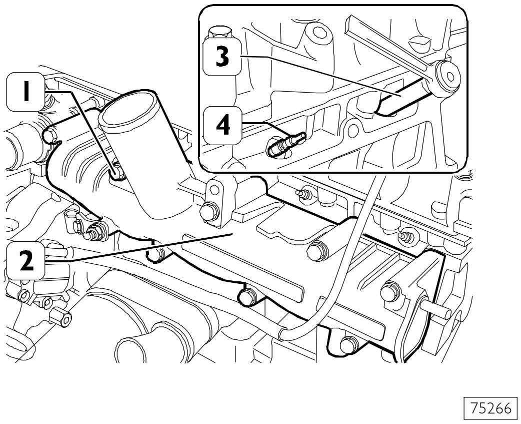


Disconnect the oil pipe (7) from the coupling of the cylinder head (1) and from the coupling of the turbocharger (3).

Take off the nuts (2) and remove the turbocharger (3) with the associated gasket from the exhaust manifold (6).

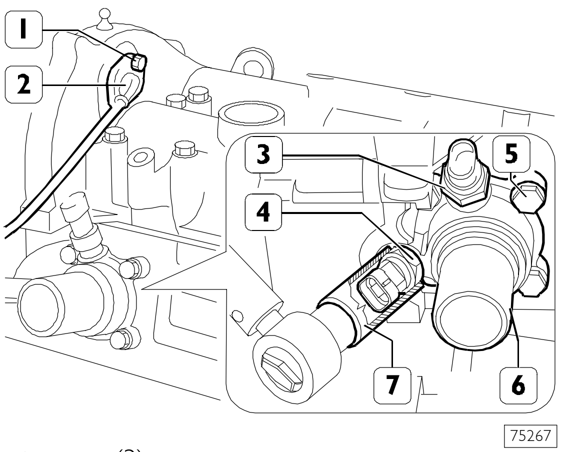
Take off the nuts (5) and the spacers (4), remove the exhaust manifold (6) with the associated gasket from the cylinder head (1).

Figure 23



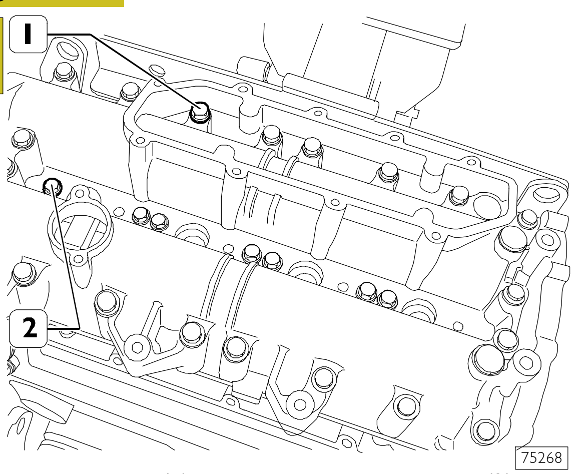
Take off screws (1) and disconnect inlet manifold (2) with its gasket.
Using wrench SP.2275 (3), remove the glow plugs (4).

Figure 24



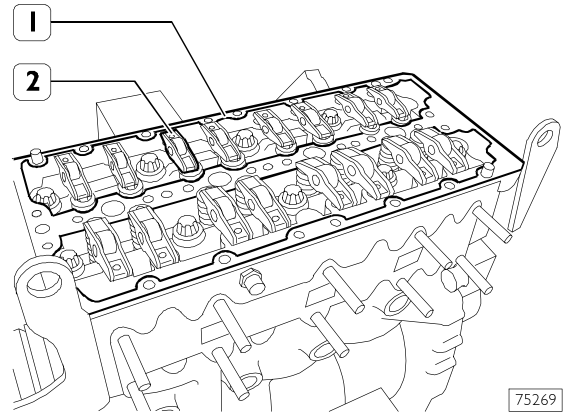
Dismount sensor (3).
Take off the nut (1) and remove the timing sensor (2). Using wrench SP.2262 (7), remove the temperature sensors (4). Take out the screws (5) and remove the thermostat box (6).

Figure 25



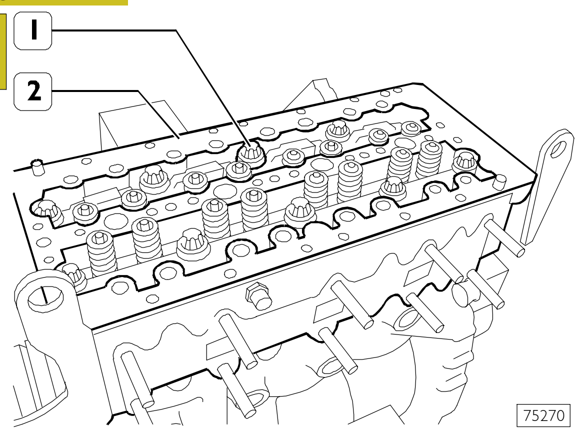
Take out the screws (1) and remove the overhead (2).
For over-head overhaul, observe what described in Section 4.

Figure 26



Take off the gasket (1) and remove the hydraulic tappets together with the rocker arms (2).

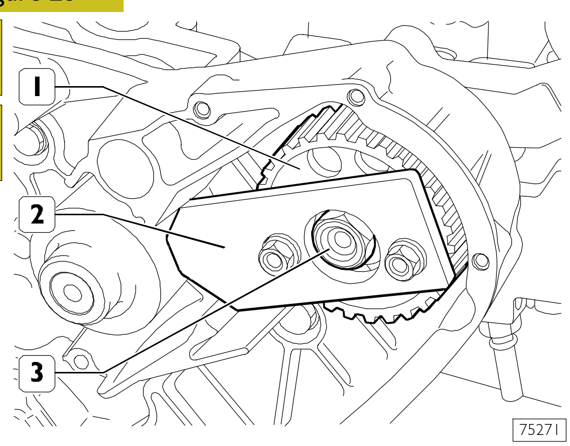
Figure 27



Take out the screws (1) and remove the cylinder head (2).
For head overhaul, observe what described in Section 4.

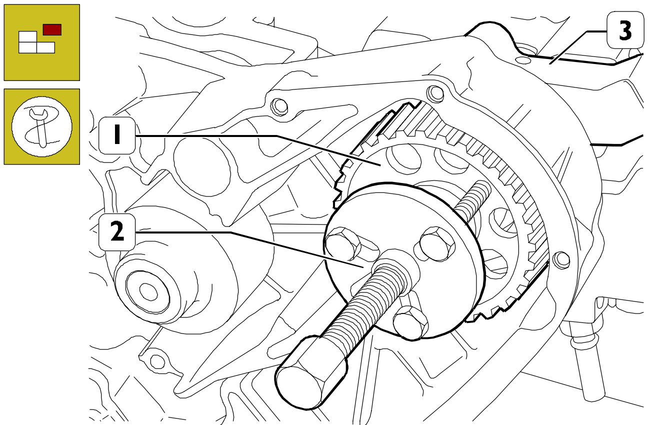
NOTE Check the protrusion of the pistons as described under the relevant heading to check the possibility of facing the crankcase if it has deformed.

Figure 28



Block rotation of the high-pressure pump gear (1) by applying tool SP 2263 (2) as shown in the figure. Take off the nut (3) and remove the tool (2).

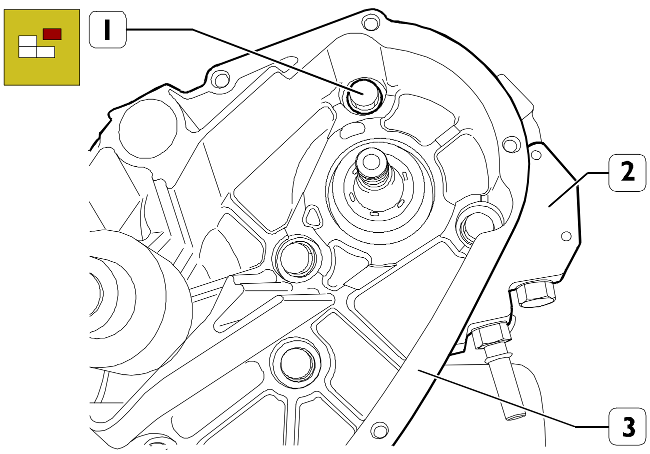
Figure 29



75272

Using tool 99340035 (2), applied as in the figure, extract the gear (1) from the shaft of the high-pressure pump (3).

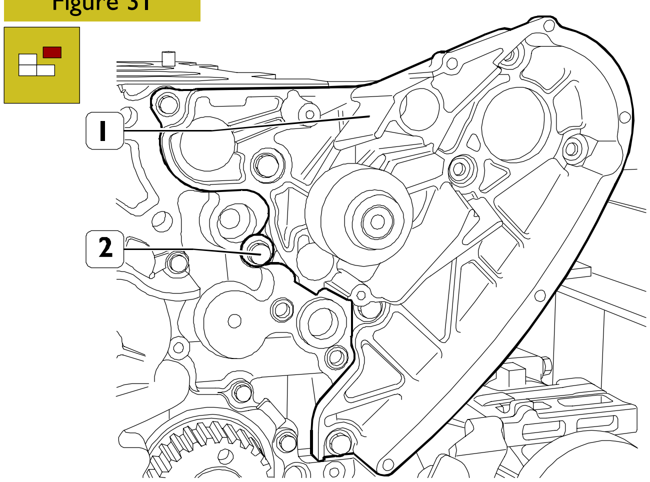
Figure 30



75273

Take out the screws (1) and remove the high-pressure pump (2) from the water pump mounting (3).

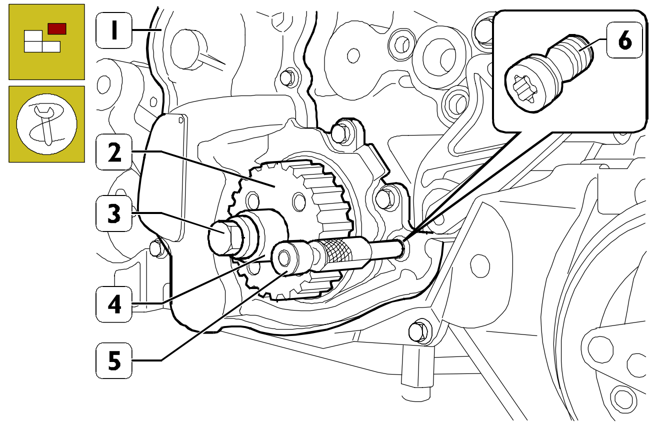
Figure 31



75274

Take out the screws (2) and remove the water pump assembly (2).

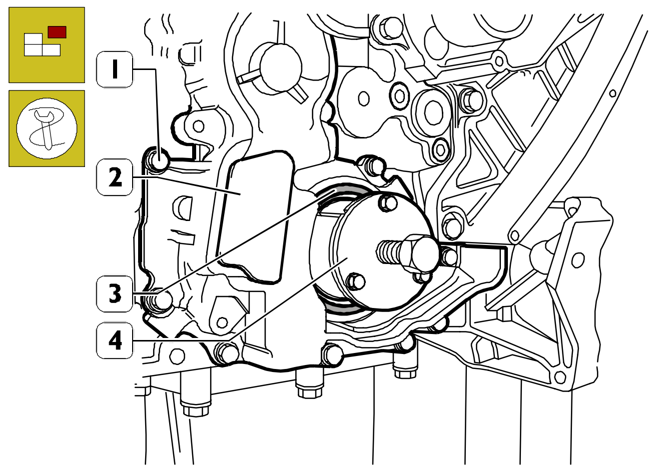
Figure 32



75275

Remove the plug (6) from the oil pump – vacuum pump assembly (1).
Position engine shaft in such a way as to be able to enter tool 99360615 (5) to lock engine shaft rotation through the hole of plug (6) into the hole of engine shaft.
Take out the screw (3) with the spacer (4) beneath and remove the gear (2).

Figure 33



75276

Apply tool 99340057 (4) to the front O-ring (3) of the crankshaft and remove it from the oil pump – vacuum pump assembly (2).
Take out the screws (1) and remove the oil pump – vacuum pump assembly (2).

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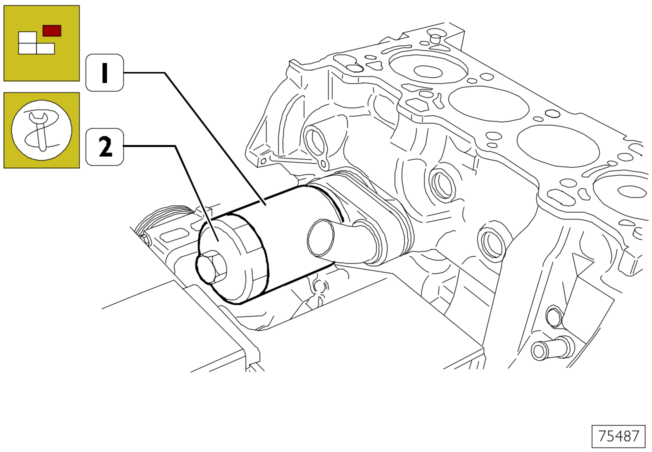
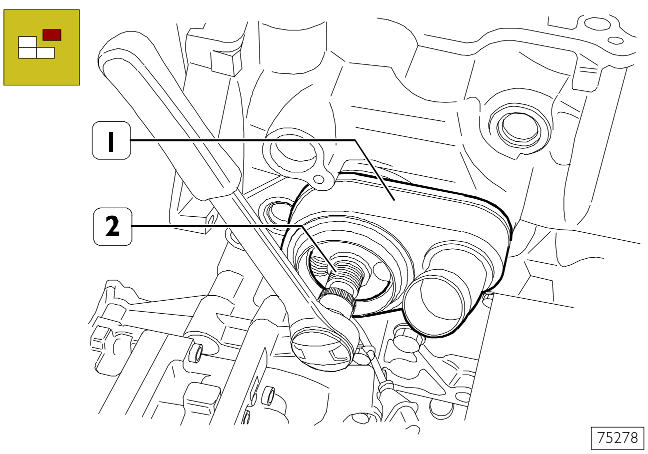
Figure 34



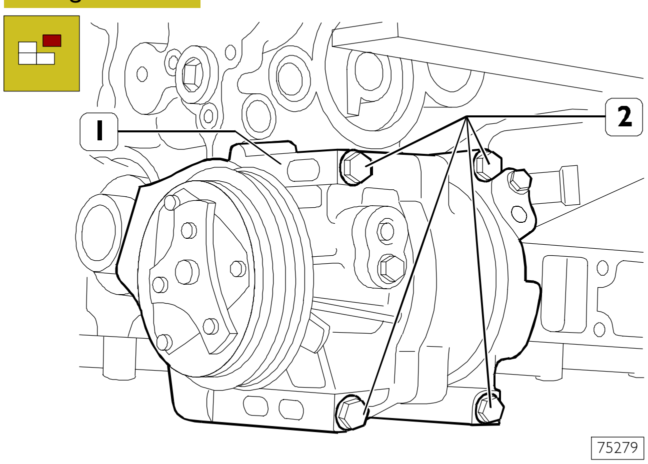
Using tool 99360076 (1), remove the oil filter (2).

Figure 35



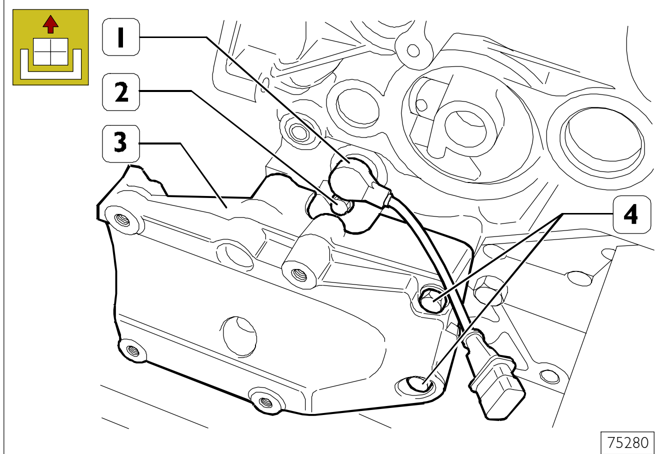
Take out the coupling (2) and remove the heat exchanger (1).

Figure 36



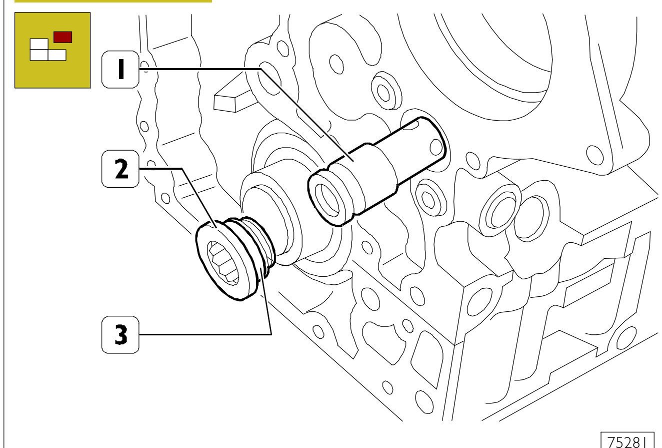
Take out the screws (2) and remove the air-conditioner compressor (1) (if applicable).

Figure 37



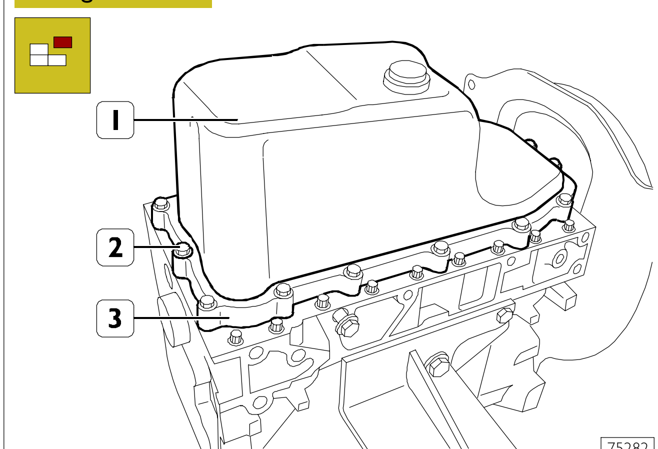
Take out the screw (2) and remove the speed sensor (1). Take out the screws (4) and remove the compressor mounting (3).

Figure 38



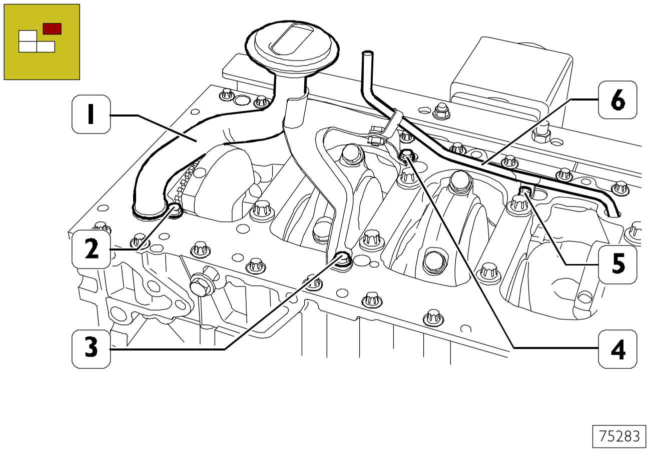
Take out the plug (2) with the seal (3) and extract the oil pressure control valve (1).

Figure 39



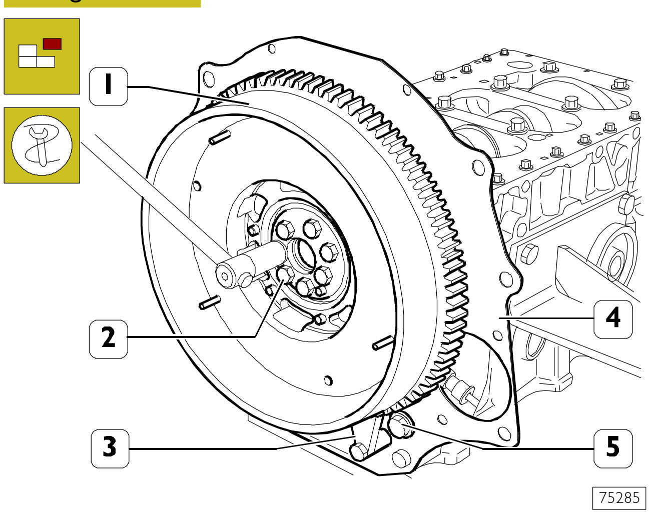
Undo the screws (2) and remove the oil sump (1) with the associated gasket and frame (3).

Figure 40



Take out the screws (2), (3), (4) and (5) and remove the suction strainer (1) together with the pipe (6).

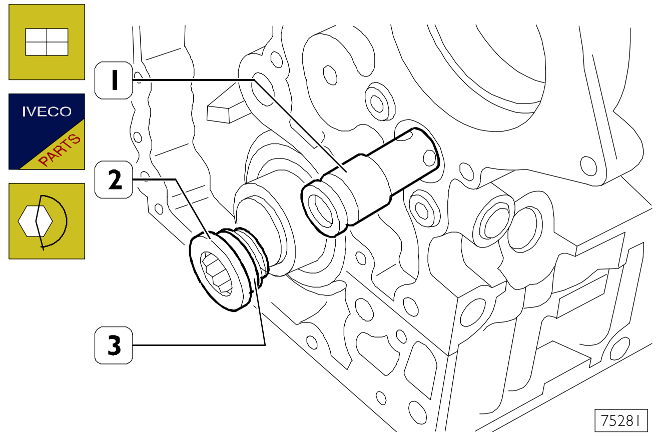
Figure 41



Block rotation of the flywheel (1) with tool 99360306 (3). Take out the screws (2) and remove the engine flywheel (1). Take out the screw (5) and remove the guard (4).

MOUNTING

Figure 42

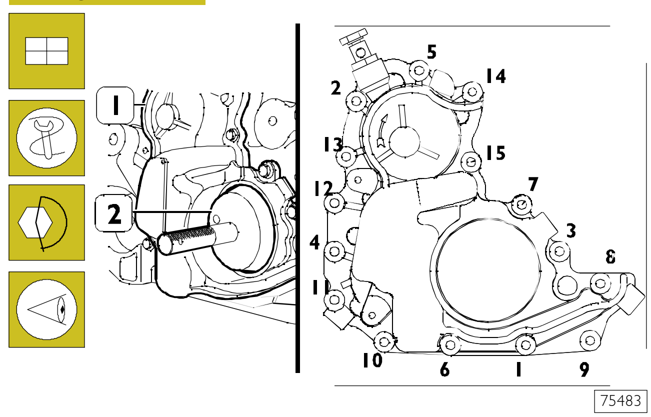


Fit the oil pressure control valve (1) in the crankcase.

Fit on the plug (2) with the seal (3) and tighten it to the prescribed torque.

Assembling front seal ring

Figure 43



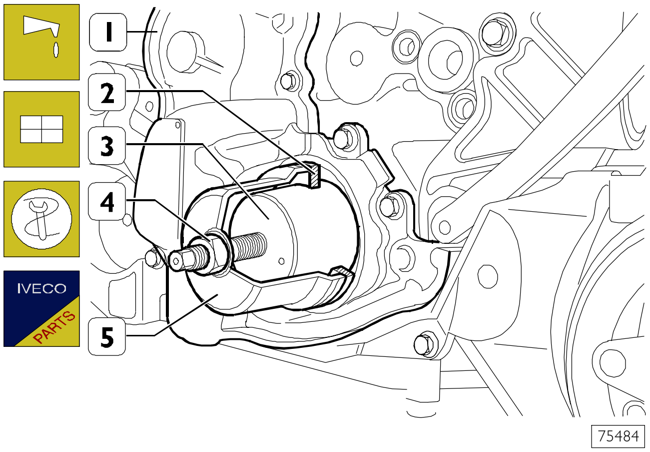
Fit the centring tool 99396037 (2) onto the shank of the crankshaft.

Mount the oil vacuum pump assembly (1) with a new gasket and tighten the screws (1-15) according to the following procedures:

- Tighten the screws from no. 1 to no. 6 to a torque of 5 ±1 Nm while checking that the tool 99360037 (2) turns freely.
- Tighten the screws from no. 7 to no. 15 to a torque of 10 ±1 Nm.
- Tighten the screws from no. 1 to no. 6 to a torque of 10 ±1 Nm.
- After checking that tool 99360037 (2) turns freely, remove it.

NOTE 0.003 ÷ 0.2 mm clearance between engine shaft gear teeth and oil pump drive gear.

Figure 44



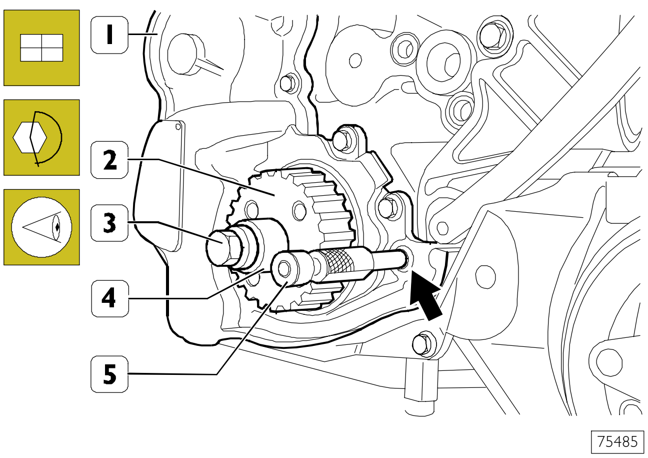
Lubricate the shank of the crankshaft.

Screw down part (3) of tool 99346254 in the crankshaft and place the seal (2) on the part (3).

Key part (5) of tool 99346254 onto part (3), screw down the nut (4) until the seal (2) gets into position in the seat of the oil vacuum pump assembly (1).

Take out the tool 99346254 (3, 4 and 5).

Figure 45

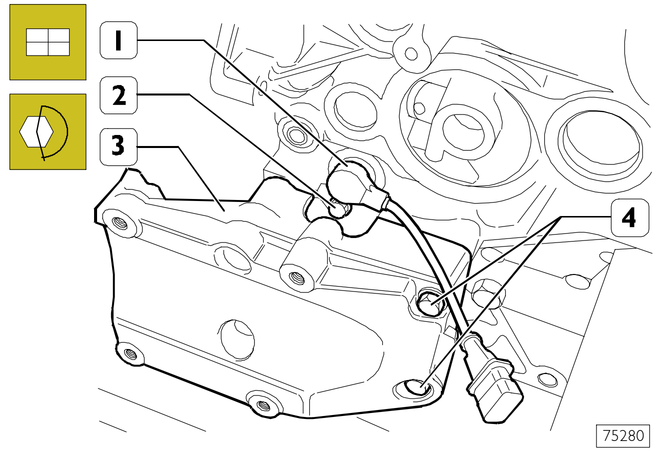


Turn the crankshaft so as to be able to insert tool 99360615 (5) into the hole in the crank of the crankshaft, through the hole in the oil vacuum pump assembly (1), to block crankshaft rotation.

Mount the gear (2), screw down the screw (3) together with the spacer (4) and tighten it to the prescribed torque.

NOTE Do not remove the tool 99360615 (5) as it will be needed for fitting the timing drive belt.

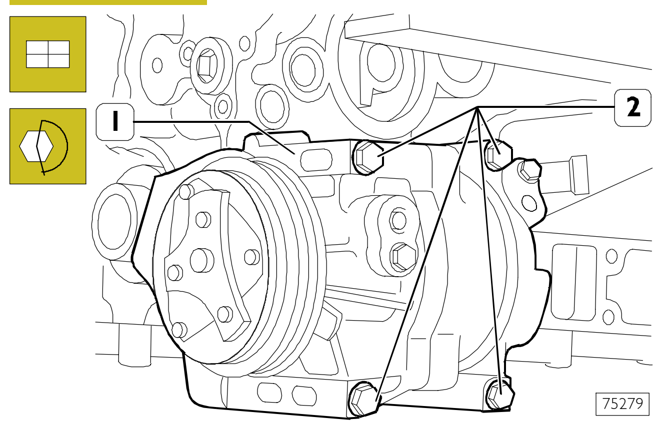
Figure 46



Mount the speed sensor (1) with a fresh gasket and tighten the fixing screw (2) to the prescribed torque (if applicable).

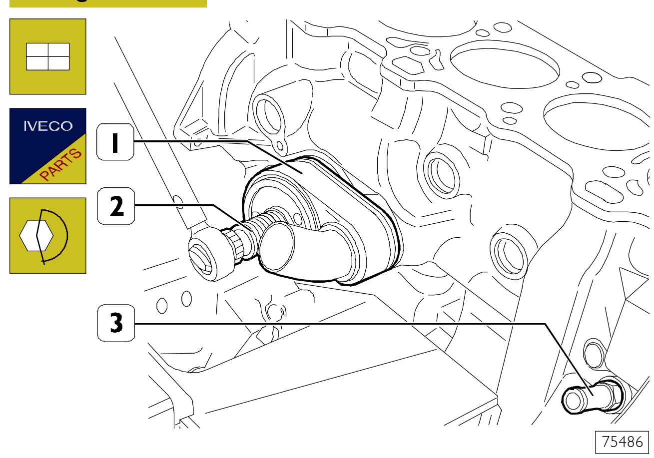
Fit on the compressor mounting (3) and tighten the fixing screws (4) to the prescribed torque.

Figure 47



Mount the air-conditioner compressor (1) (if applicable) and tighten its fixing (2) screws to the prescribed torque.

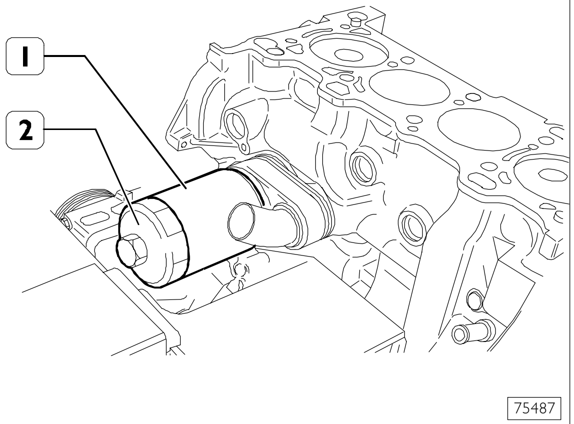
Figure 48



Mount the oil pressure transmitter (3) with a fresh gasket.

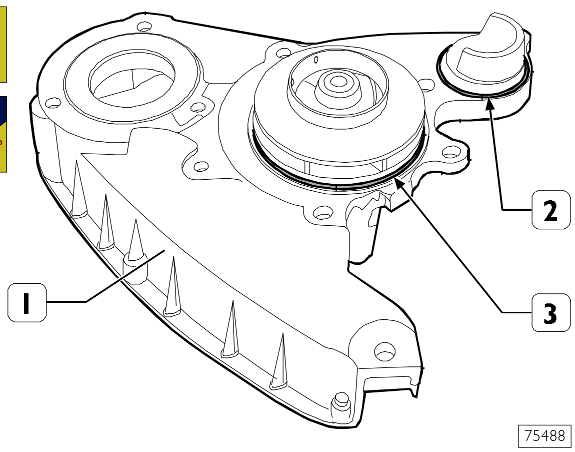
Mount the heat exchanger (1) with a fresh seal and tighten the coupling (2) to the prescribed torque.

Figure 49



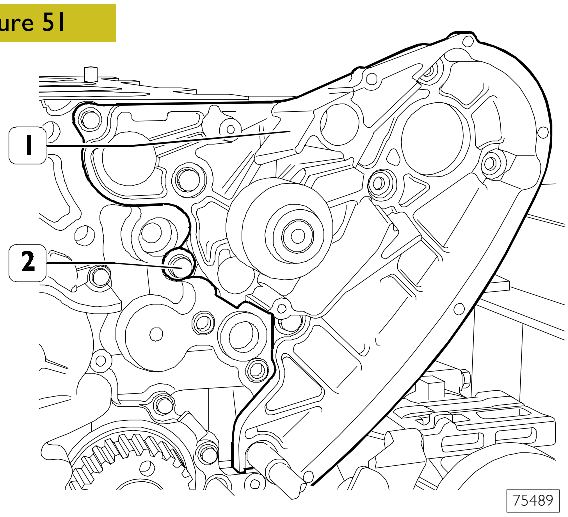
Lubricate the seal of the oil filter (1) with engine oil.
Using tool 99360076 (2), tighten the oil filter to the prescribed torque.

Figure 50



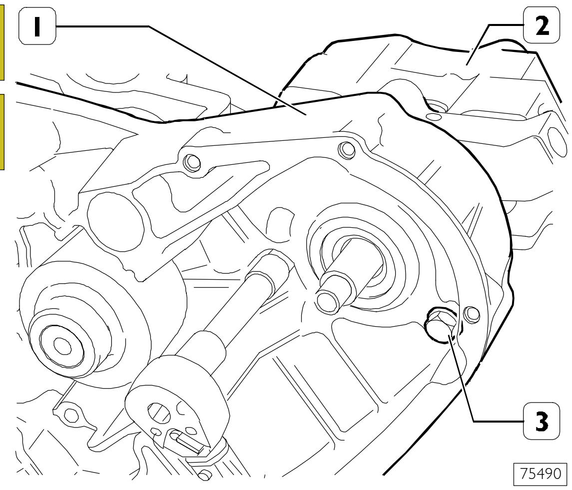
Thoroughly clean the mating surface (→) of the water pump (1) and position fresh seals (2 and 3) on it.

Figure 51



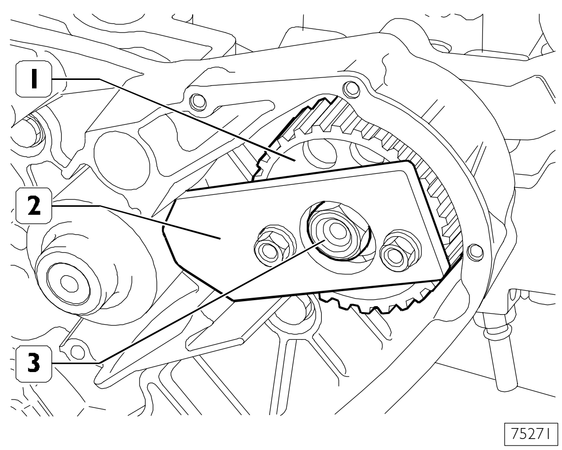
Mount the water pump (1) and tighten the fixing screws (2) to the prescribed torque.

Figure 52



Fit the high-pressure pump (2) onto the flange of the water pump (1) and tighten the fixing screws (3) to the prescribed torque.

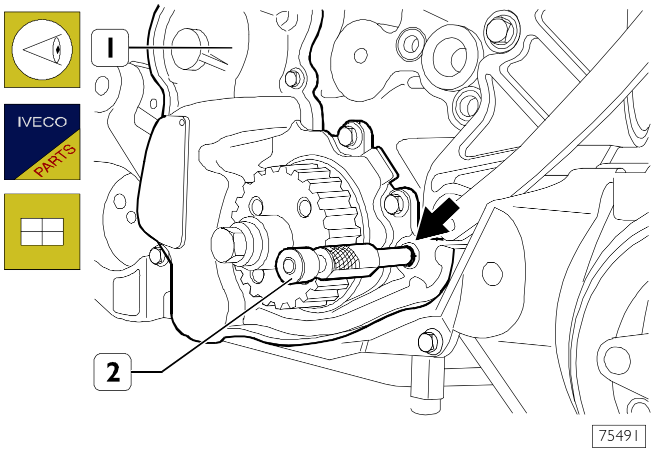
Figure 53



Fit the driving gear (1) onto the shaft of the high-pressure pump and block rotation of this shaft by applying tool SP.2263 (2) as illustrated in the figure. Tighten the nut (3) to the prescribed torque and remove the tool (2).

Refitting cylinder head

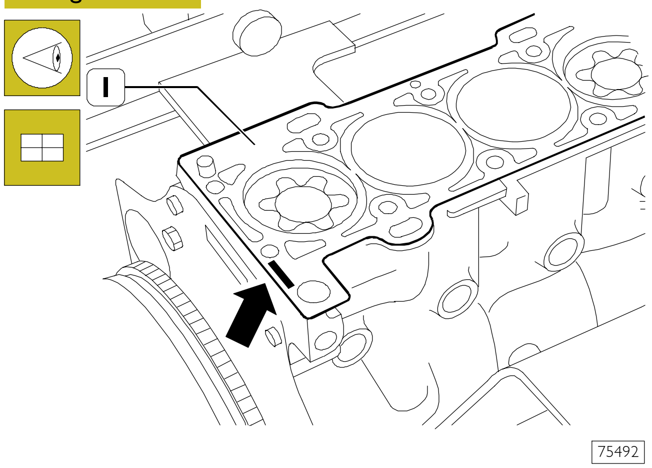
Figure 54



Check that tool 99360619 (2) inserted in the hole (→) of the oil vacuum pump assembly (1) blocks crankshaft rotation.

This condition is necessary for setting up the timing system and to prevent the valves interfering with the pistons.

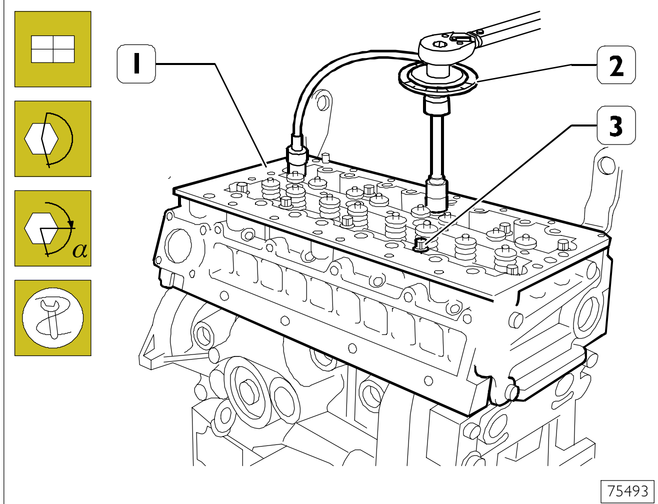
Figure 55



Check that the mating surfaces of the cylinder head and crankcase are clean.
Keep the cylinder head gasket clean.
Position the cylinder head gasket (1) of the thickness determined under the heading "checking piston protrusion" with the lettering "TOP" facing the cylinder head.

NOTE It is essential to keep the gasket sealed in its package until just before assembly.

Figure 56



Mount the cylinder head (1).

Screw down the fixing screws (3) and tighten them, in three successive stages, following the order and methods shown in the following figure.

NOTE The angle closure is done with tool 99395216 (2).

Figure 57

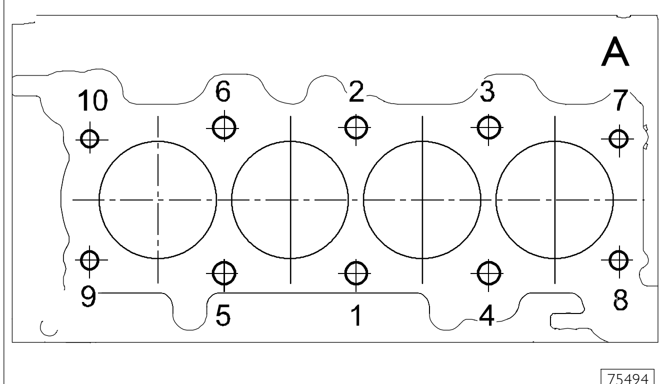
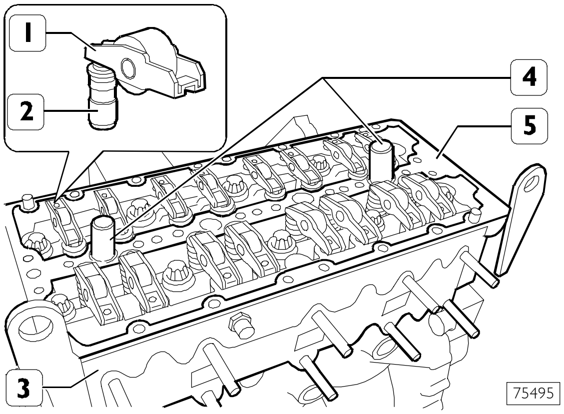


Diagram of the tightening sequence for the cylinder head fixing screws:

- ❑ 1st phase: pre-tightening with torque wrench
  - screws 1-2-3-4-5-6 to a torque of 100 ±5 Nm;
  - screws 7-8-9-10 to a torque of 50 ±2.5 Nm.
- ❑ 2nd phase: angle closing
  - screws 1-2-3-4-5-6 90° ±5°;
  - screws 7-8-9-10 60° ±3°.
- ❑ 3rd phase: angle closing
  - screws 1-2-3-4-5-6 90° ±5°;
  - screws 7-8-9-10 60° ±3°.

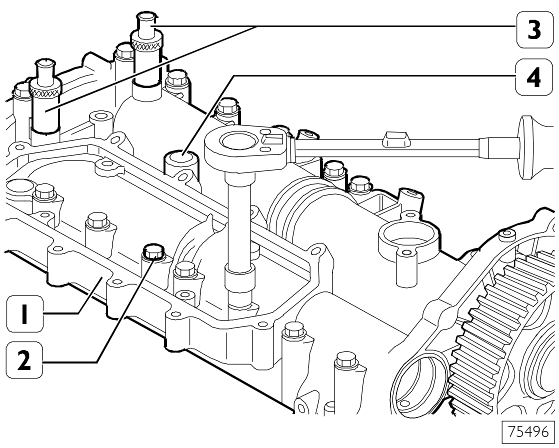
A = flywheel side.

Figure 58



Thoroughly clean the hydraulic tappets (2), lubricate them and fit them in the cylinder head (3), positioning the rocker arms (1) on the valves correctly.
Fit on the gasket (5).
Insert the two tools SP. 2264 (4) into the electro-injector seats for subsequent centring of the overhead on the cylinder head.

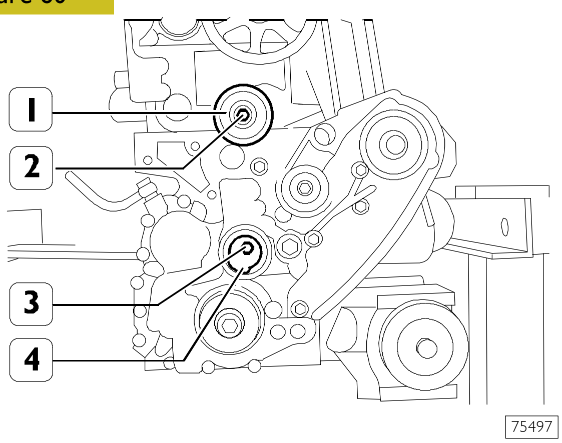
Figure 59



Mount the overhead (1) together with the tools 99360614 (3) for the timing and tighten the fixing screws (2) to the prescribed torque.

Take out the tools SP. 2264 (4).

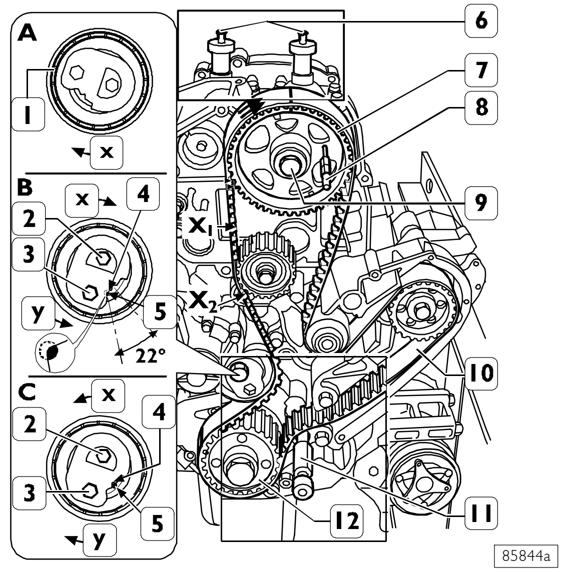
Figure 60



Mount the fixed tightener (1) and tighten the fixing screw (2) to the prescribed torque.

Mount the automatic tightener (4) without fully tightening the fixing screw (3), max. closing torque 5 Nm.

Figure 61



X = Direction of movement of the tightener –
Y = Direction of rotation of the key.

Turn the automatic tightener (1) clockwise, positioning it as shown in frame A.
Turn the timing belt (10) as shown in the figure observing the precautions below.
Do not bend the timing belt. Arrows indicating the direction of assembly of the timing belt on the engine are shown on the back of the belt. The arrows must correspond to the direction of rotation of the belt and the notches must coincide with those on the pulley (7) and the gear (12).
If required to fit the timing belt (10) on the pulley (7), remove tool 99360608 (8) and turn the pulley (7) clockwise by no more than half a pulley tooth.

NOTE If the engine has run for a period equivalent to ≥ 25,000 km, the toothed belt must be replaced with a fresh one, no matter what its state of wear.

On completing assembly, adjust the toothed pulley (7) to put the section X of the belt under tension and tighten the screw (9) to a torque of 90 Nm
Keeping the screw (2) stationary and using a suitable wrench on the hexagon of the plate (3) of the tightener, turn it anticlockwise to cover the reference hole (5) located on the fixed portion of the tightener (see frame B).
In the above conditions, tighten the fixing screw (2) to a torque of 36 ± 4 Nm
Remove the tools 99360614 (6) and 99360615 (11) for the timing.
Turn the engine in its direction of rotation by 8 turns to be able to put the tools (6) and (11) back in to do the timing.
In these conditions, the notches of the timing belt (10) must coincide with those of the pulley (7) and the gear (12).

NOTE Do not turn the engine in the opposite direction; if, on turning the engine, you pass the point for inserting the tools (6) and (11), turn the engine clockwise by another two turns.

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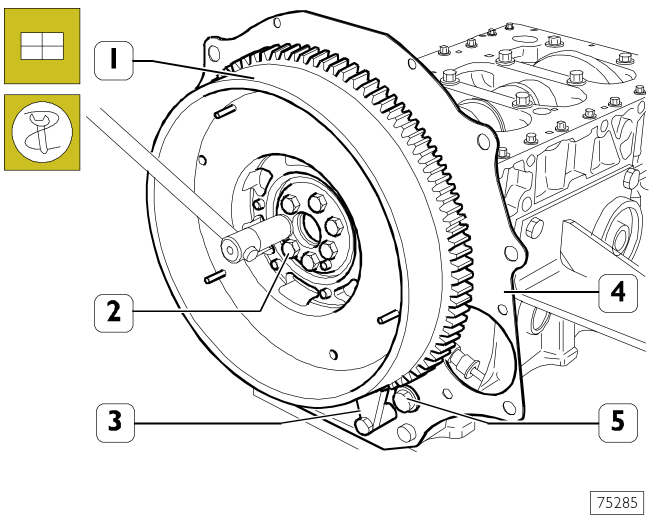
See frame C: Figure 61, holding the tightener plate (3) stationary with the wrench inserted in its hexagon, loosen the fixing screw (2). Keeping the fixing screw (2) stationary, turn the plate (3) clockwise until its reference mark (4) coincides with the reference hole (5) of the fixed portion of the tightener. In the above conditions, tighten the screw (2) to a torque of 36 ±4 Nm.
After assembly, the belt (10) tension measured using tool 99395849 must be as follows in the following points: X = 212 ± 12 Hz -X_1 = 178 ± 10 Hz.

Figure 62

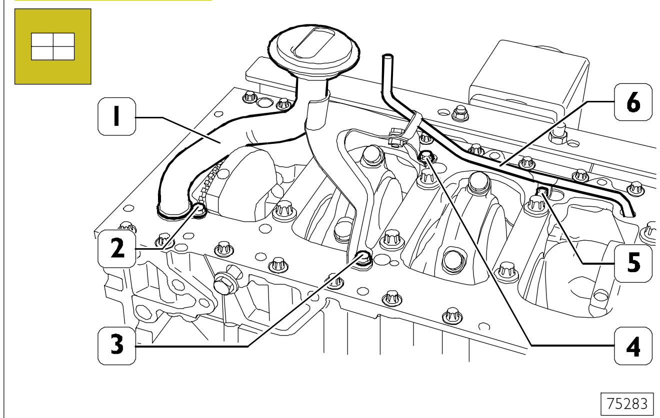


Mount guard (4) by securing screws (5).
Mount flywheel (1) by screws (2) without tightening it with a high torque.
Fasten tool (3) 99360306 before tightening it screws (2) with a high torque.
Screws (2) must be tightened with specific torques in two steps:

1st step with a dynamometric wrench with 30 Nm torque.

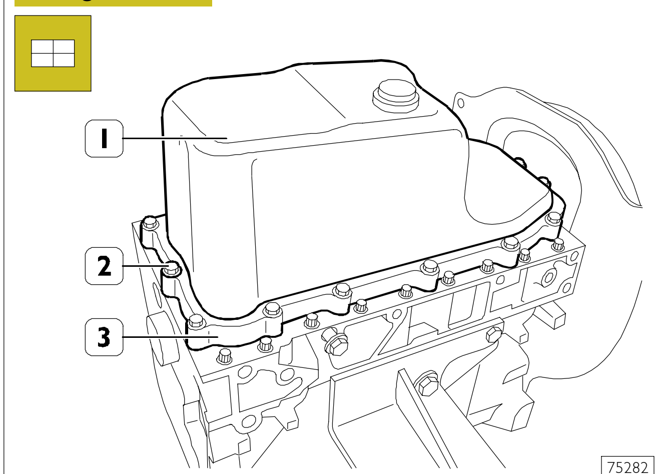
2nd step clamping with 90° angle.

Figure 63



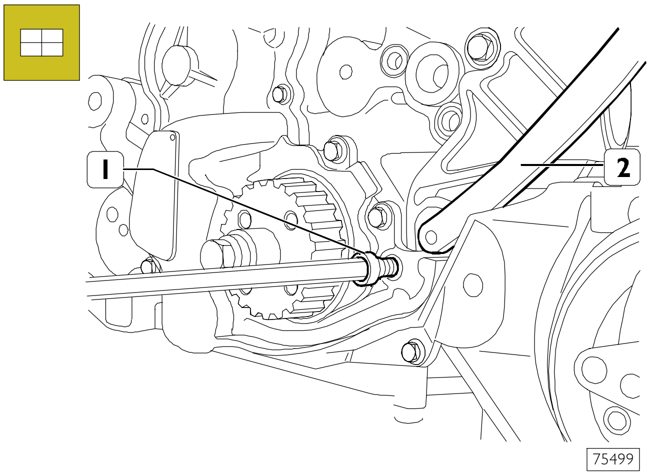
Mount suction rose (1) complete with piping (6) by screws (2), (3), (4) and (5).

Figure 64



Unscrew screws (2) and remove oil sump (1) with its gasket and frame (3).
Fasten oil sump (1) with its gasket and frame (3) by screws (2).

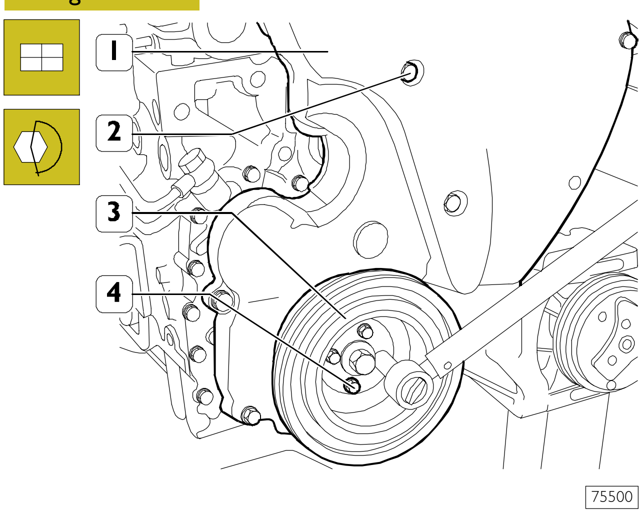
Figure 65



Remove the tools (6 and 11, Figure 61).

Screw the plug (1) into the oil-vacuum pump mounting (2) and the plugs on the holes of the overhead.

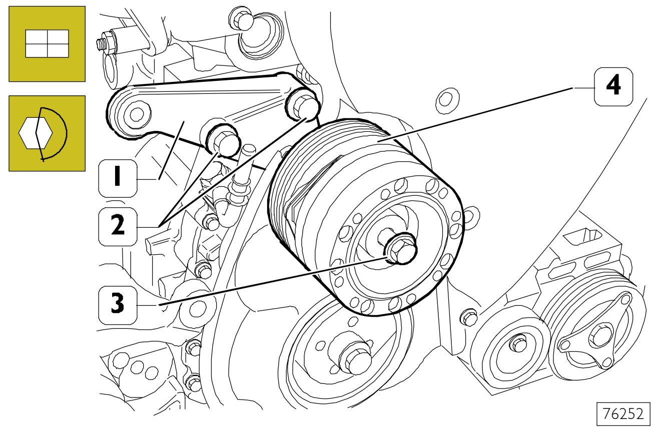
Figure 66



Mount the timing cover (1) and tighten the screws (2) to the prescribed torque.

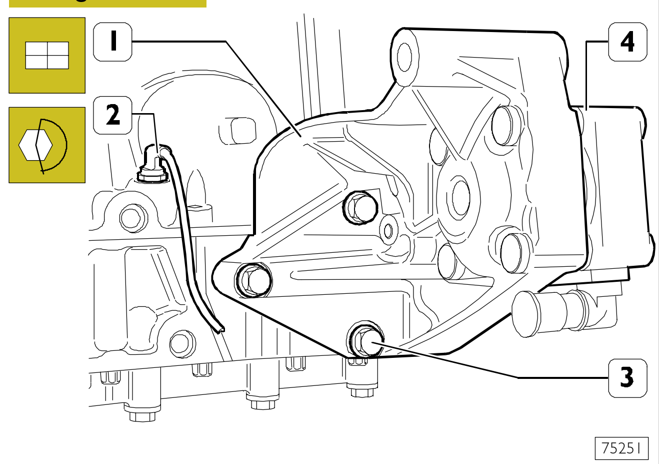
Mount the damper pulley (3) and tighten the screws (4) to the prescribed torque.

Figure 67



Fit on the mounting (1) together with the electromagnetic coupling (4) and tighten the fixing screws (2 and 3) to the prescribed torque.

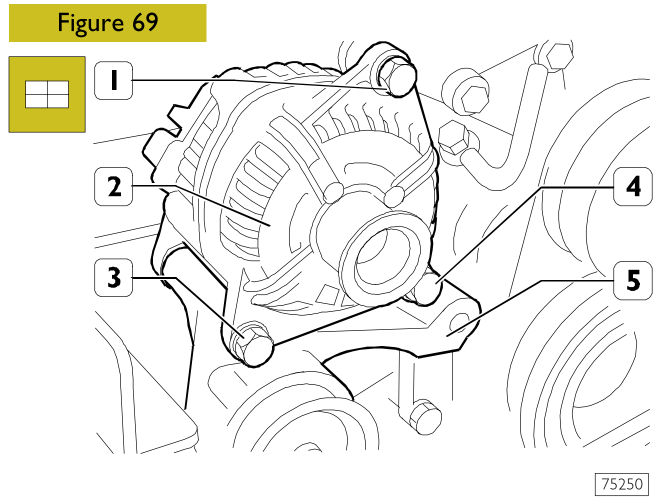
Figure 68



Mount the oil level sensor (1).

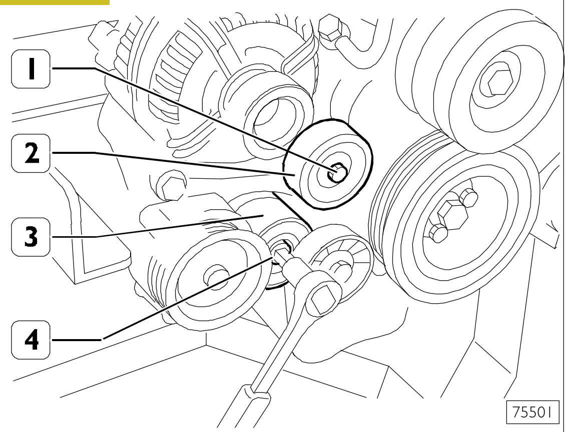
Fit on the power steering (2) pump mounting (4) and tighten the fixing screws (3) to the prescribed torque.

Figure 69



Position the alternator (2) on the mounting (5) and secure it with the bottom screws (3 and 4) and the bolt.

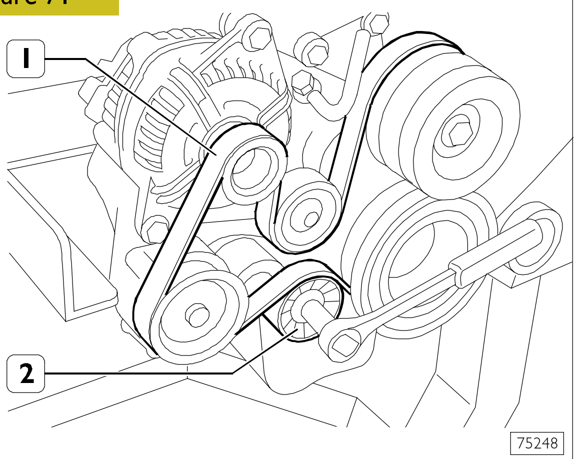
Figure 70



Mount the fixed tightener (2) and tighten the fixing screw (1).

Mount the automatic tightener (3) and tighten the screw (4) to the prescribed torque.

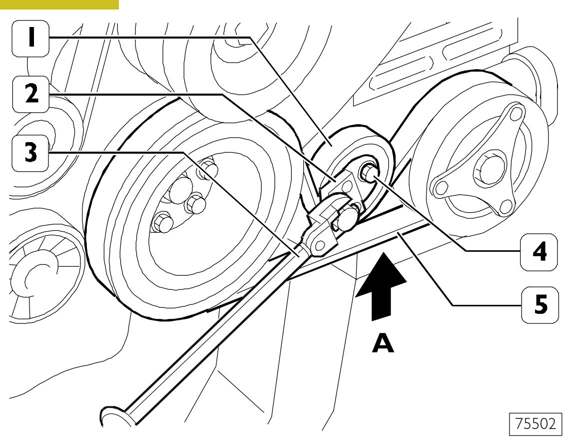
Figure 71



Using a wrench on the automatic tightener (2), mount the drive belt (1), taking care to position its ribs correctly in the respective races of the pulleys.

Adjusting air-conditioner – compressor drive belt tension

Figure 72



Fit the tightener (1) without tightening the screw (4).
Fit the drive belt (5) taking care to position its ribs correctly in the respective races of the pulleys.

With tool SP. 2341 (2) inserted in the holes of the tightener (1) and torque wrench (3), turn the tightener (1) with a torque of 8.2 – 10 Nm; in this condition, tighten the screw (4) to a torque of 25 Nm.

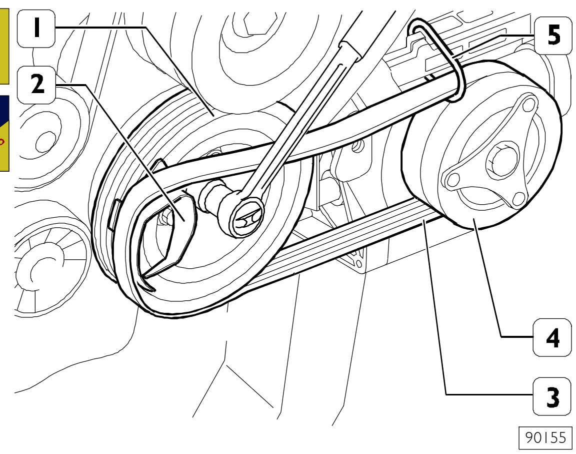
Turn the engine in its direction of rotation to have the belt (5) make two full turns.

With appliance 99395849, measure the tension of the belt (5) in section **A**, which must be 204 ±10 Hz corresponding to a load on the tightener of 1010 ± Nm.

In the case of engines with a compressor drive belt of elastic type, no tensioning is needed. For mounting, operate as follows.

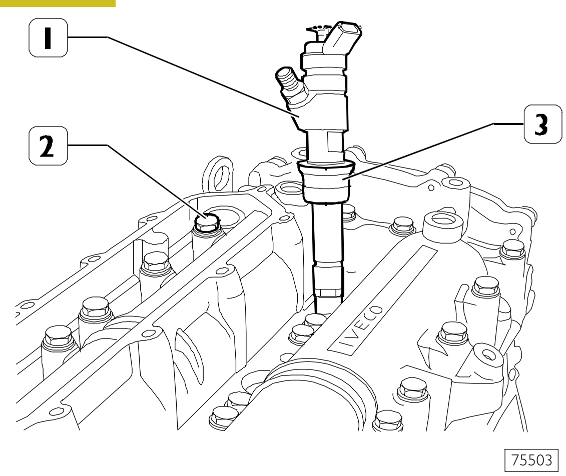
NOTE The elastic belt must be replaced by a new elastic belt at each dismounting operation.

Figure 73



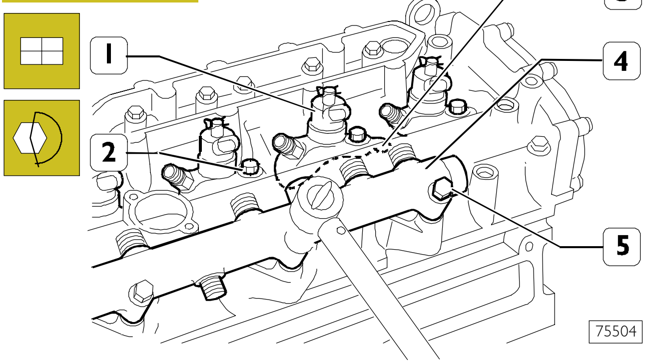
Fit the flexible belt (3) equipped with tool 99360191 (2) on the pulley (4) and apply the tool on the pulley (1).
Fit the drive ring (5) on the flexible belt (3) and fasten the ring on the compressor support.
Turn the drive shaft clockwise until the belt fits perfectly on the pulley (1).

Figure 74



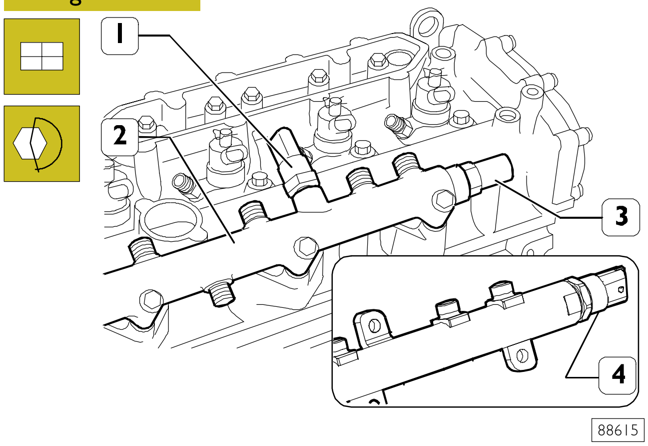
Fit a new seal (3) on the electro-injector (1) and mount this in the overhead (2).

Figure 75



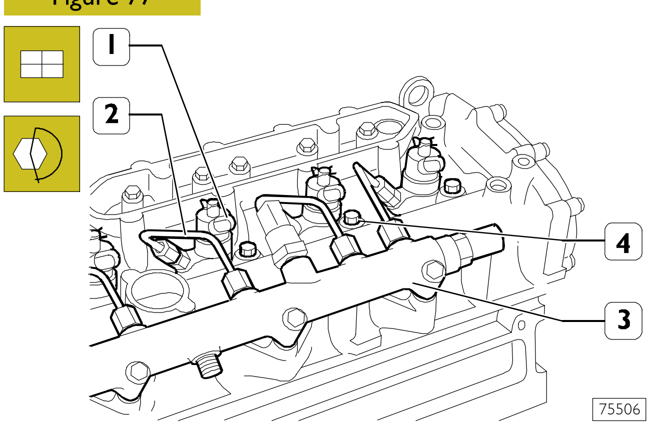
Mount the brackets (3) fastening the electro-injectors (1) and screw down the screws (2) without locking them.
Mount the hydraulic accumulator (4) and tighten the fixing screws to the prescribed torque.

Figure 76



Forged version: on hydraulic accumulator (2), mount: pressure sensor (1) tightening it at 35 ± 5 Nm torque, and pressure relief valve (3) tightening it at 27 ± 2 Nm torque.
Welded version: mount pressure sensor and tighten it at 70 ± 5 Nm torque.

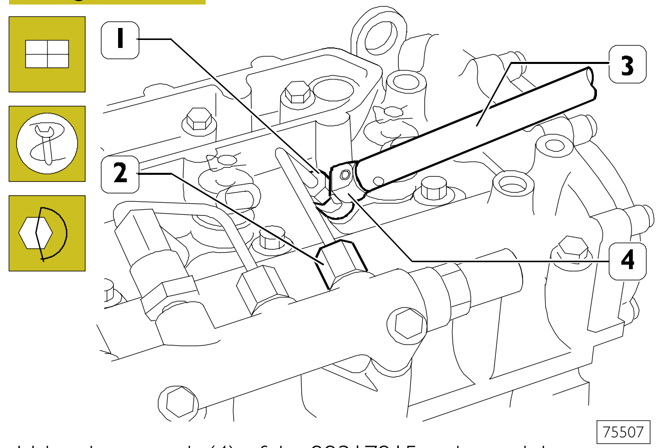
Figure 77



Connect the fuel pipes (2) to the electro-injectors (1) and to the hydraulic accumulator (3).
Tighten the screws (4) fixing the electro-injector brackets to the prescribed torque.

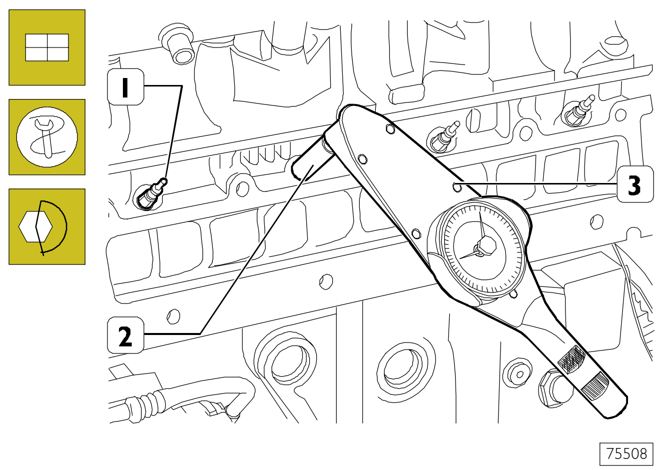
NOTE Whenever they get removed, the fuel pipes must be replaced with new ones.

Figure 78



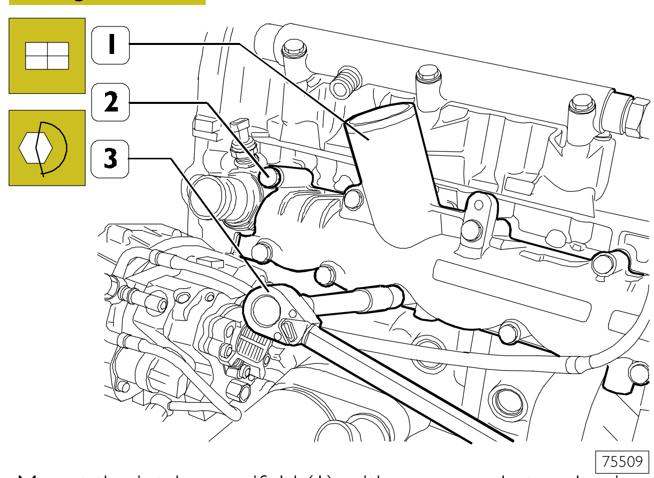
Using the wrench (4) of the 99317915 series and the torque wrench 99389829 (3), tighten the fuel pipe fittings (1) and (2) to the prescribed torque.

Figure 79



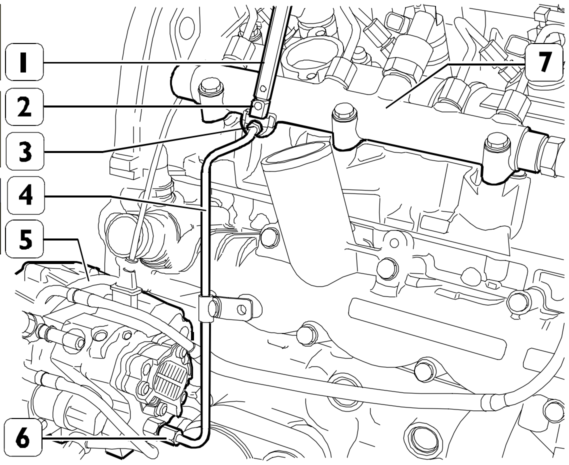
Mount the glow plugs (1) and, using the box-type wrench SP. 2275 (2) and torque wrench 99389819 (3), tighten them to a torque of 8 ÷ 10 Nm.

Figure 80



Mount the intake manifold (1) with a new gasket and, using a torque wrench (3), tighten the fixing screws (2) to the prescribed torque.

Figure 81

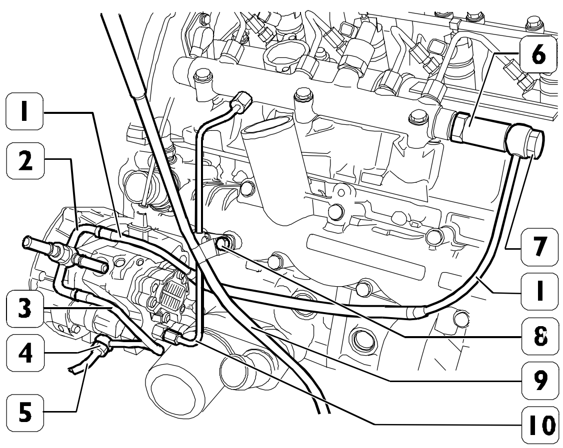


75510

Connect the fuel pipe (4) to the hydraulic accumulator (7) and to the high-pressure pump (5).
With wrench (2) of series 99317915 and dynamometric wrench 99389829 (1), tighten pipe fittings (3 and 6) at prescribed torque.

NOTE Whenever they get removed, the fuel pipes (4) must be replaced with new ones.

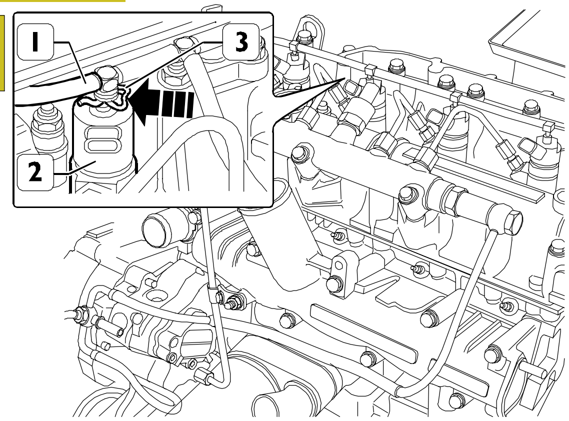
Figure 82



75511

Connect the fuel recovery pipe (1) with new seals to the pressure relief valve (6) tightening the coupling (7) to the prescribed torque (only for forged version hydraulic accumulator).
Connect the fuel recovery pipes (1) and (5) with new seals to the high-pressure pump (2) with the couplings (3) and (4).
Insert the oil dipstick tube (9) with a new seal into the crankcase and secure it together with the pipe (10), using the screw (8) tightened to the prescribed torque, to the intake manifold.

Figure 83



75256

Press the clips (3) in the direction shown by the arrow and connect the fuel recovery pipe fittings (1) to the electro-injectors (2).

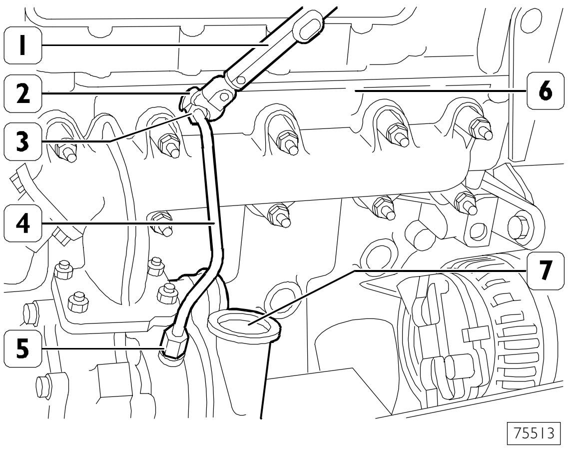
Figure 84

75512

Fit the exhaust manifold (5) with a new gasket and the spacers (6) and tighten the nuts (7) to the prescribed torque.
On the exhaust manifold (6), mount: the turbocharger (4) with a new gasket and tighten the nuts (3) with washers to the prescribed torque, the compensator pipe (1) (if applicable) with a new seal and tighten the nuts (2) with washers to the prescribed torque.

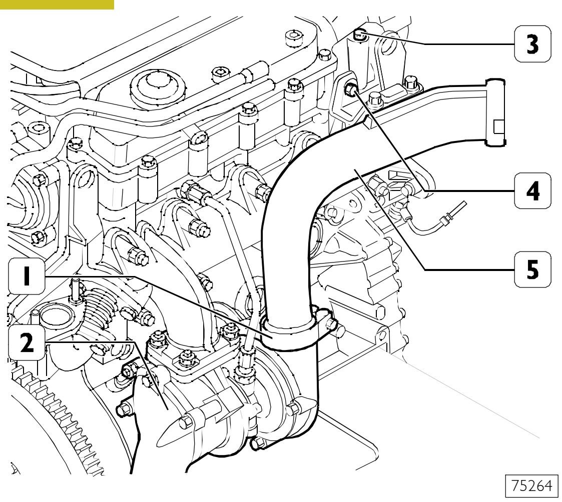
NOTE Before fitting the turbocharger on the engine, it is necessary to fill the central body with engine lubricating oil.

Figure 85



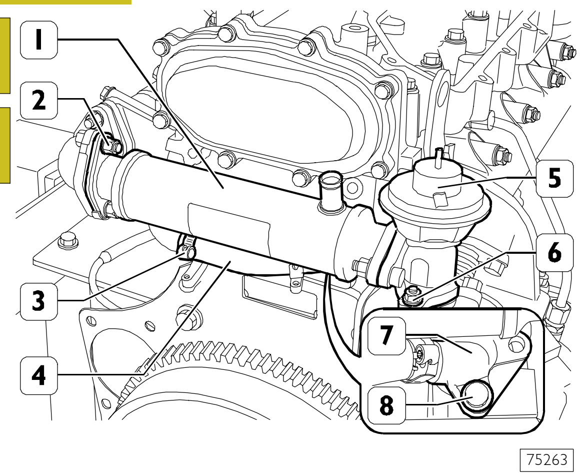
Connect the pipe (4) to the cylinder head (6) and to the turbocharger (7).
Using the wrench (2) in the 99317915 series and the torque wrench 99389829 (1), tighten the couplings (3 and 5) to the prescribed torque.

Figure 86



Connect the air duct (5) to the turbocharger (2) and to the overhead (3).
Tighten the clamp (1) and the screw (4) to the prescribed torque.

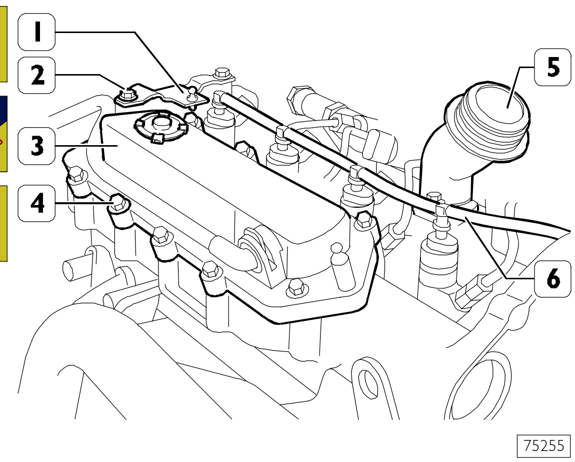
Figure 87



For engines with E.G.R. only

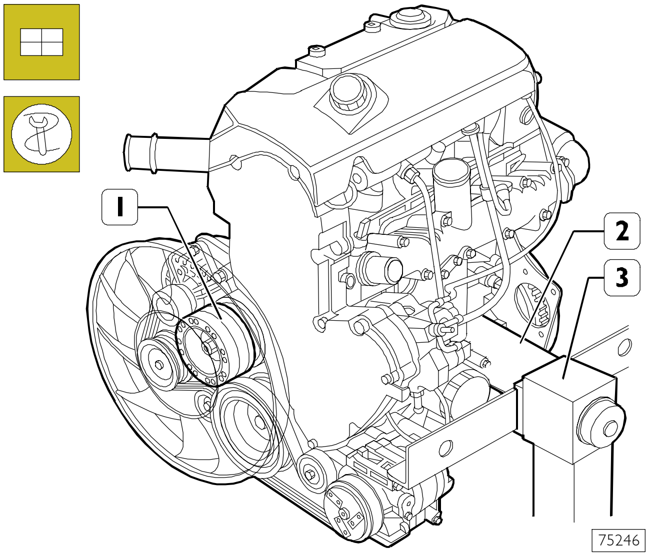
Mount the flange (7) with a new gasket and tighten the screws (8) to the prescribed torque.
Mount the heat exchanger (1) together with the E.G.R. valve (5) and new gaskets and tighten the screws (2 and 6) to the prescribed torque.
Connect the pipe (4) to the exchanger (1) and to the flange (7) securing it with the clamps (3).

Figure 88



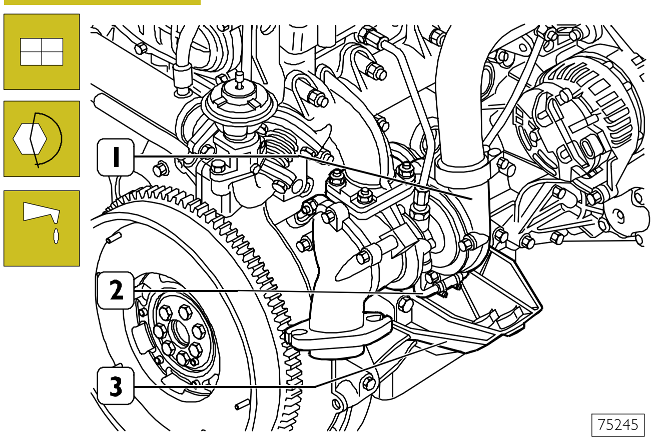
Mount the oil fillpipe (5) with a new seal and tighten the nuts (6) to the prescribed torque.
Mount the coalescence filter (3) and tighten its fixing nuts (4) to the prescribed torque.
Mount the bracket (1) and tighten the screws (2) to the prescribed torque.

Figure 89



Fit the cooling fan (1) back onto the electromagnetic coupling. Fit the arm 99360549 onto the engine lifting hooks. Hook the arm onto the hoist and remove the engine from the rotary stand (3). Take out the brackets 99361028 (2).

Figure 90

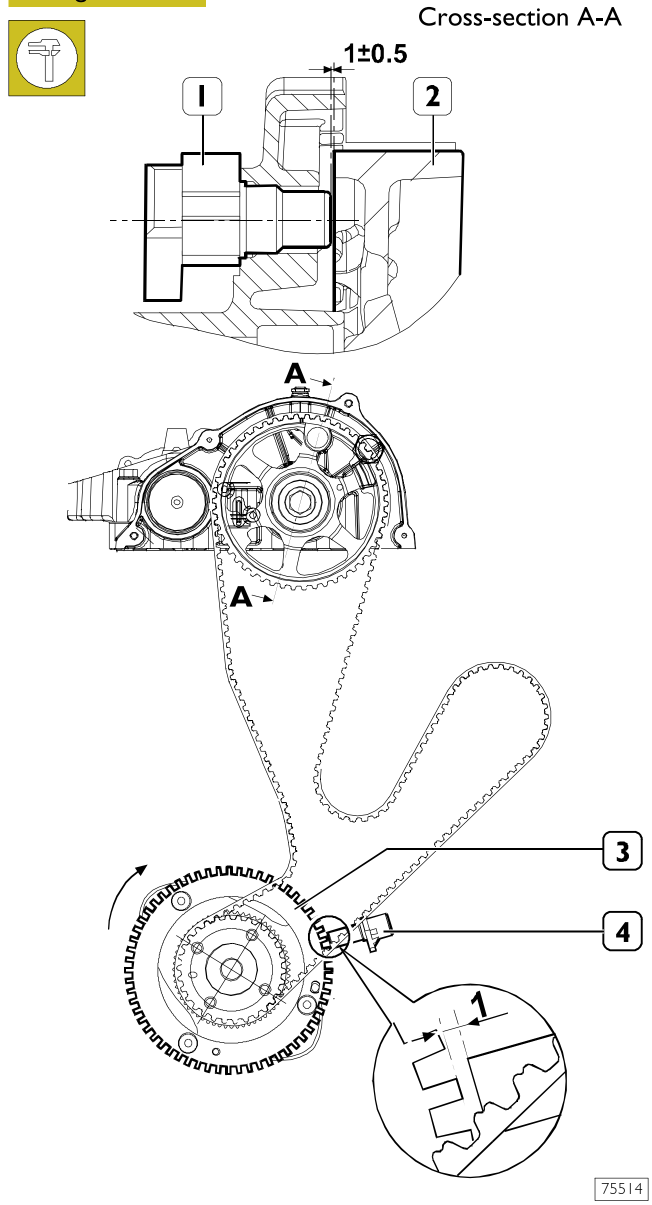


Complete engine assembly.
Fit on the left and right engine mountings (3) and tighten the fixing screws to the prescribed torque.
Connect the oil pipe (2) to the turbocharger (1) and to the crankcase and tighten the fixing screws and the coupling of the oil pipe (2) to the prescribed torque.
If applicable, mount the following parts:

- Engine cable, connecting its electrical connections to the thermostat temperature sensor, timing sensor, engine speed sensor, pressure regulator, rail pressure sensor and intake manifold air pressure/temperature sensor.
- Hydraulic accumulator guard.
- Top soundproofing cover.
- Add the prescribed grade and quantity of lubricating oil to the engine.

Timing speed sensor
Engine speed sensor

Figure 91



The sensor gap is:

- 1 ±0.5 mm, between the camshaft pulley (2) and timing sensor (1).
- 1 mm, between the phonic wheel (4) and speed sensor (3).

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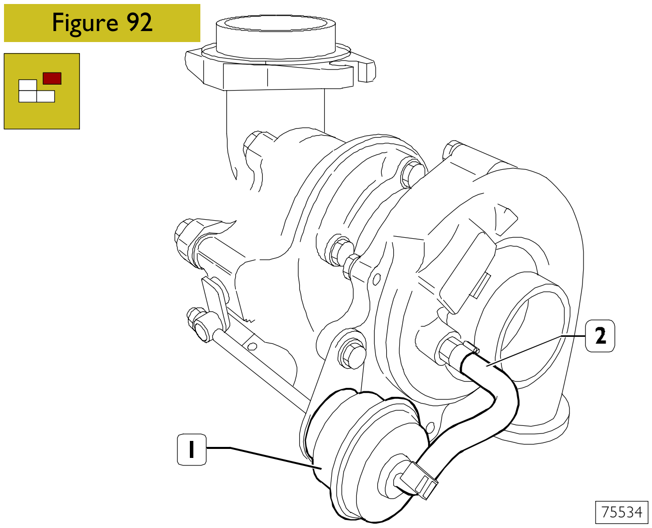
REPAIRS

NOTE On finding irregular engine operation due to the turbocharging system, it is first expedient to perform the checks on the turbocharger, check the efficiency of the seals and the fixing of the couplings, additionally checking there is no clogging in the intake sleeves, air filter or radiators. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not burst or clogged, in which case replace them or eliminate the trouble.

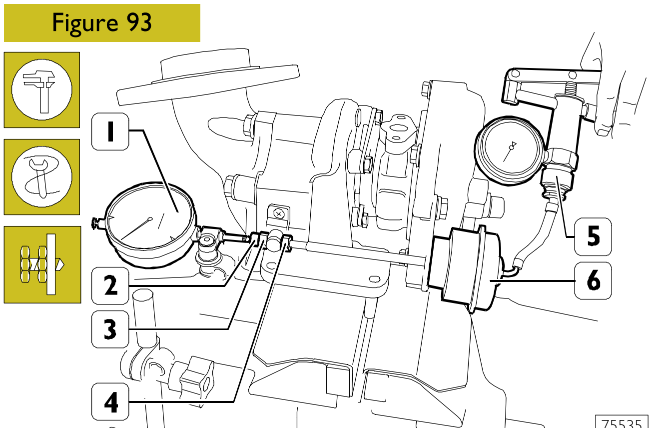
Pressure relief valve
Checking and adjusting pressure relief valve

Figure 92



Cover the air, exhaust gas and lubricating oil inlets and outlets. Thoroughly clean the outside of the turbocharger using anticorrosive and antioxidant fluid. Disconnect the pipe (2) from the union of the pressure relief valve (1) and fit on it the pipe of the device 99367121 (1, Figure 93).

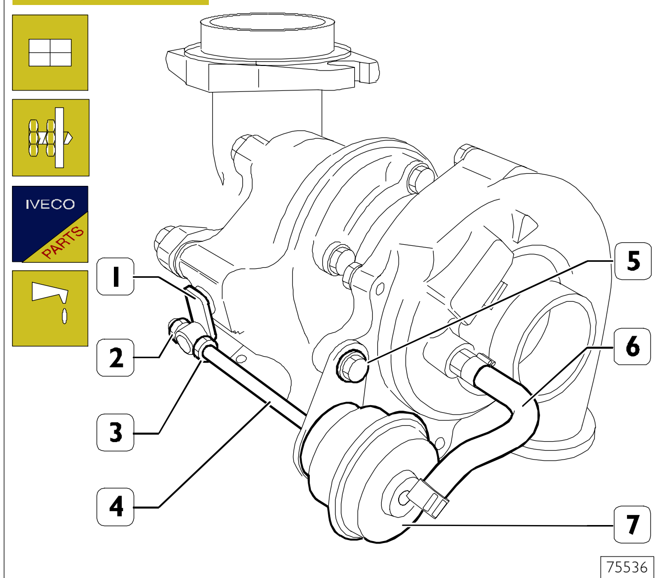
Figure 93



Rest the tip of the dial gauge (1) with a magnetic base on the end of the tie rod (2) and zero it. Using the device 99367121 (5), introduce compressed air into the valve casing (6) at the prescribed pressure and make sure this value stays constant throughout the check; replace the valve if it doesn't. In the above conditions, the tie rod must have made the prescribed travel. On finding a different value, use the nuts (3 and 4).

Replacing pressure relief valve

Figure 94

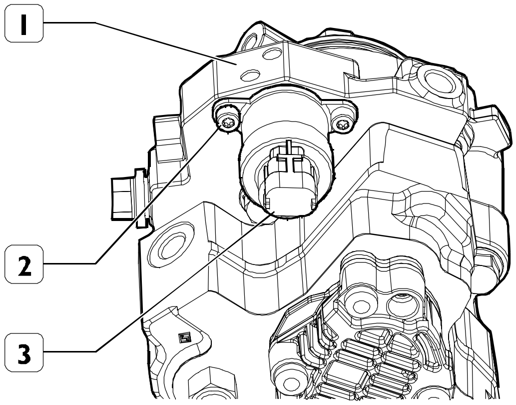


Take off the nut (2).
Take out the screws (5) and detach the bracket together with the relief valve (7) from the turbocharger.
Mount the new valve, performing the operations for disassembly in reverse order, and register it as follows:
Screw the nut (3) onto the stem (4) of the valve down to the end of the thread. Mount the lever (1) on the valve stem.
Using device 99367121 (5, Figure 93), introduce compressed air into the valve (7) at the prescribed pressure; in this condition, screw down the nut (2) until the throttle valve controlled by the lever (1) gets positioned in its seat.
Unscrew the nut (3) to bring it into contact with the lever (1) and at the same time block the nuts (2 and 3).
Adjust the pressure relief valve (7) as described under the relevant heading.
Afterwards, paint the nuts (2 and 3) with safety paint and connect the pipe (6) to the valve (7), securing it with a new retaining clamp.

NOTE Before fitting the turbocharger on the engine, it is necessary to fill the central body with engine lubricating oil.

Replacing pressure regulator.

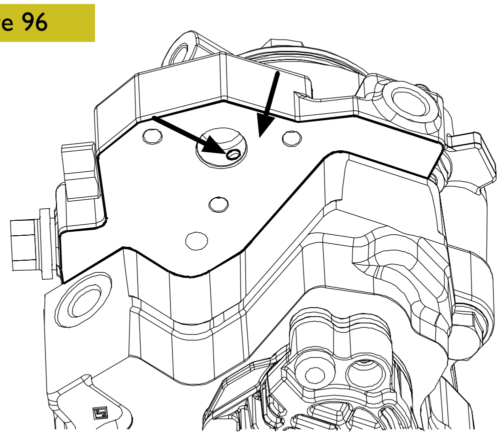
Figure 95



88406

Accurately clean high pressure pump.
Take off screws (2) and unthread pressure regulator (3) from high pressure pump.

Figure 96

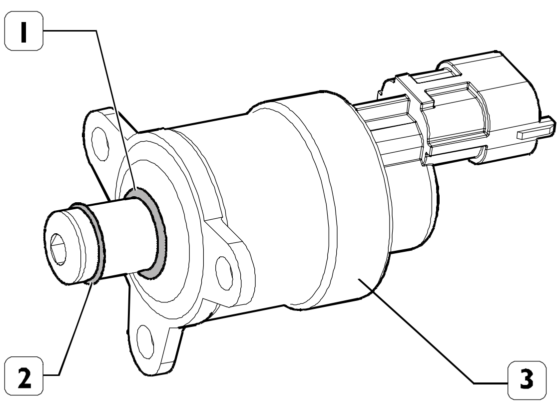


88407

Accurately clean the seat (→) of pressure regulator and the connection surface (→) of the regulator.

NOTE For cleaning, do not use a tool which could damage the surfaces and pay attention that impurities are not introduced into channels.

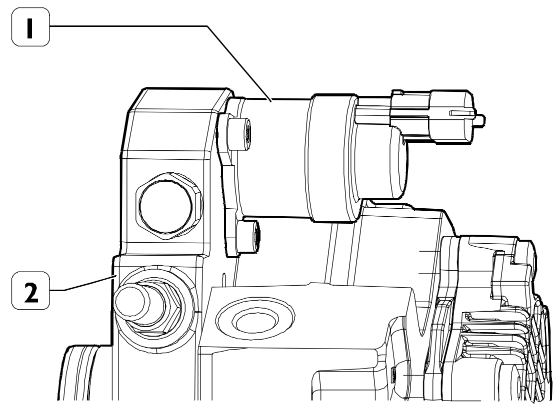
Figure 97



88408

Mount new seal rings (1 and 2) on pressure regulator (3) and lubricate the rings with vaseline.

Figure 98

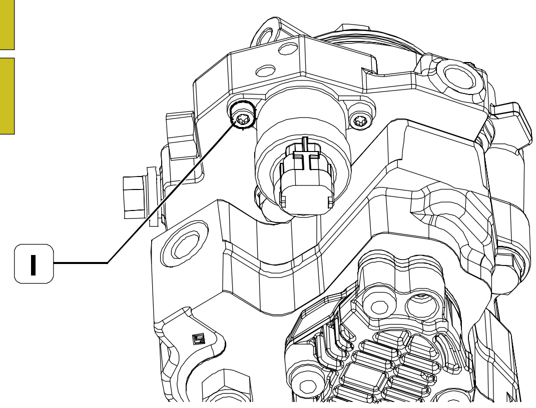


88409

Mount pressure regulator (1) on high pressure pump (2).

NOTE Mounting operation must be performed keeping the regulator perpendicular to connection plane without angling it, in order not to damage seal rings (1-2, Figure 97).

Figure 99



88410

Screw up screws (1) and tighten them at 6 ÷ 7 Nm (0.6 ÷ 0.7 kgm) torque.

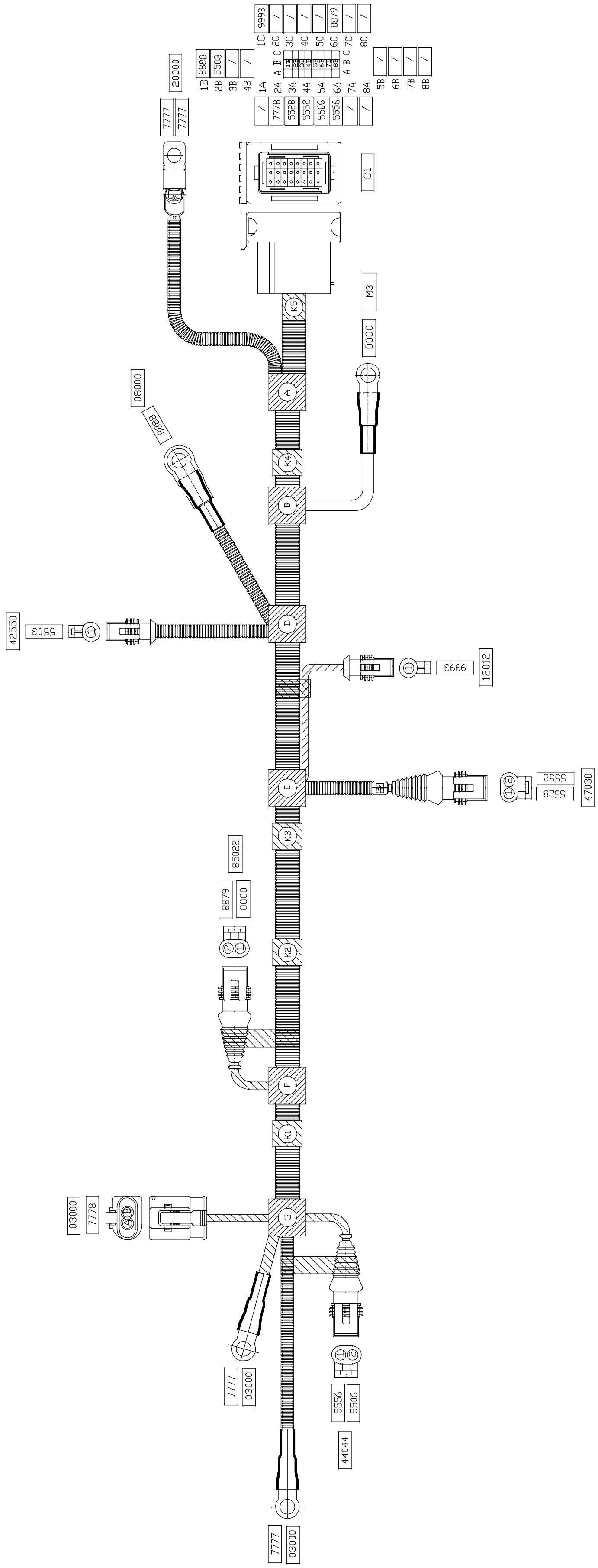
NOTE Where pressure regulator is replaced on the engine mounted on the vehicle, it is needed, after replacement, to check that there are no fuel leaks after an engine working period.

PART TWO -

ELECTRICAL EQUIPMENT

F1A ENGINE HARNESS

Figure 1



74267

Component code	Description
00000	Ground
03000	Self-rectifying alternator with integrated voltage regulator
08000	Starter motor
12012	A/C compressor
20000	Starter battery
42550	Engine oil low pressure indicator switch
44044	Low engine oil level indicator control
47030	Transmitter for engine water temperature thermometer
85022	Electromagnetic coupling for engine cooling
C1	Engine service harness connector

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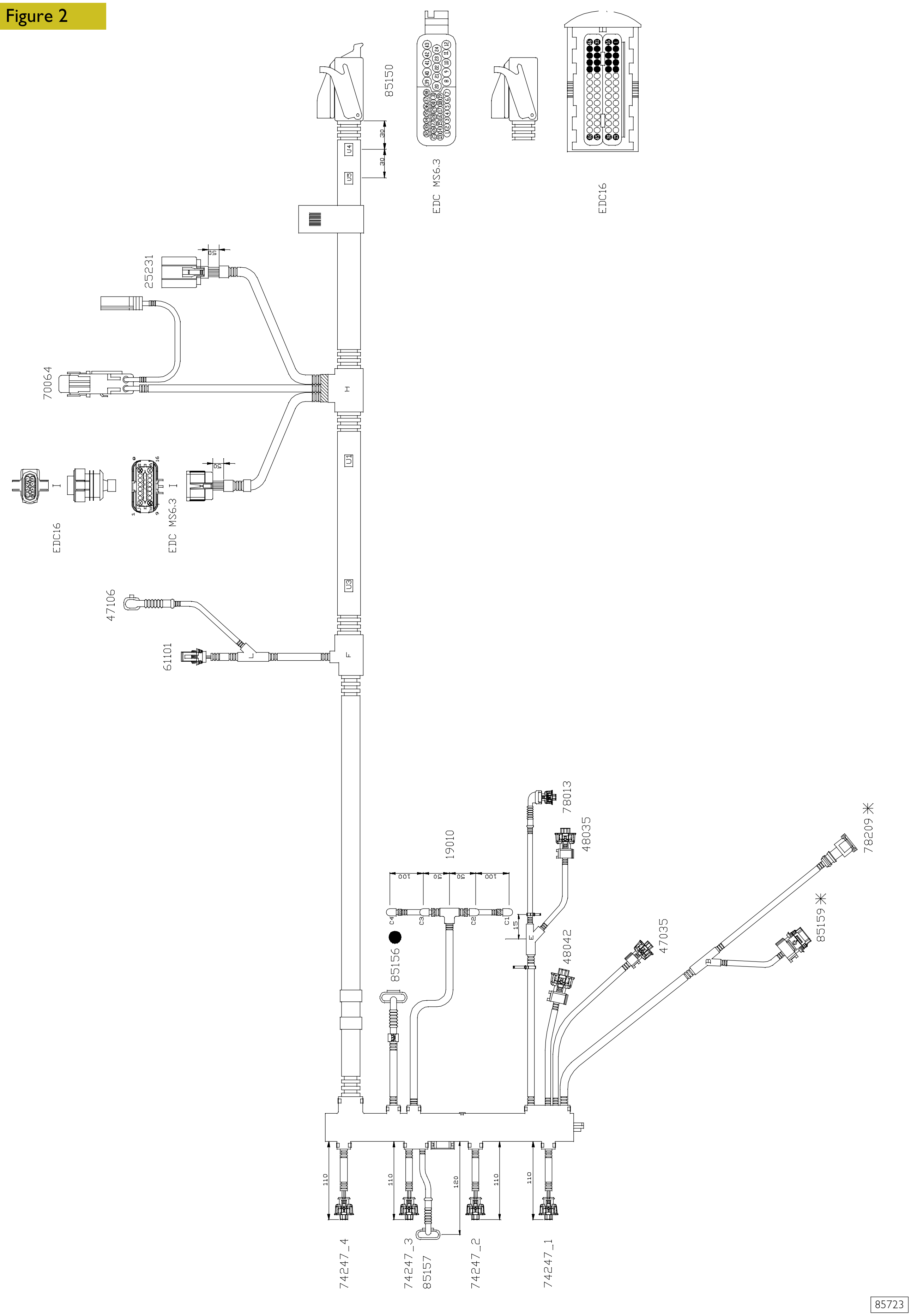
Injection cable F1A

Figure 2



Component code	Description
85150	EDC center
1	Connection to hood cab cable
47035	Coolant temperature sensor
85157	Fuel pressure sensor
78247	Electrical injection electro valve
48042	rpm sensor on distributor
48035	Engine rpm sensor
78013	Pressure adjustment electro valve
47106	Fuel heat on switch
● 85156	EDC blower air pressure sensor
61101	Fuel heat resistor
19010	Preheat plug
25231	Plug insert centre
70064	1-way fuse holder
* 85159	Environment air temperature and pressure sensor for EDC
* 78209	EGR electro valve

● Without EGR
* With EGR

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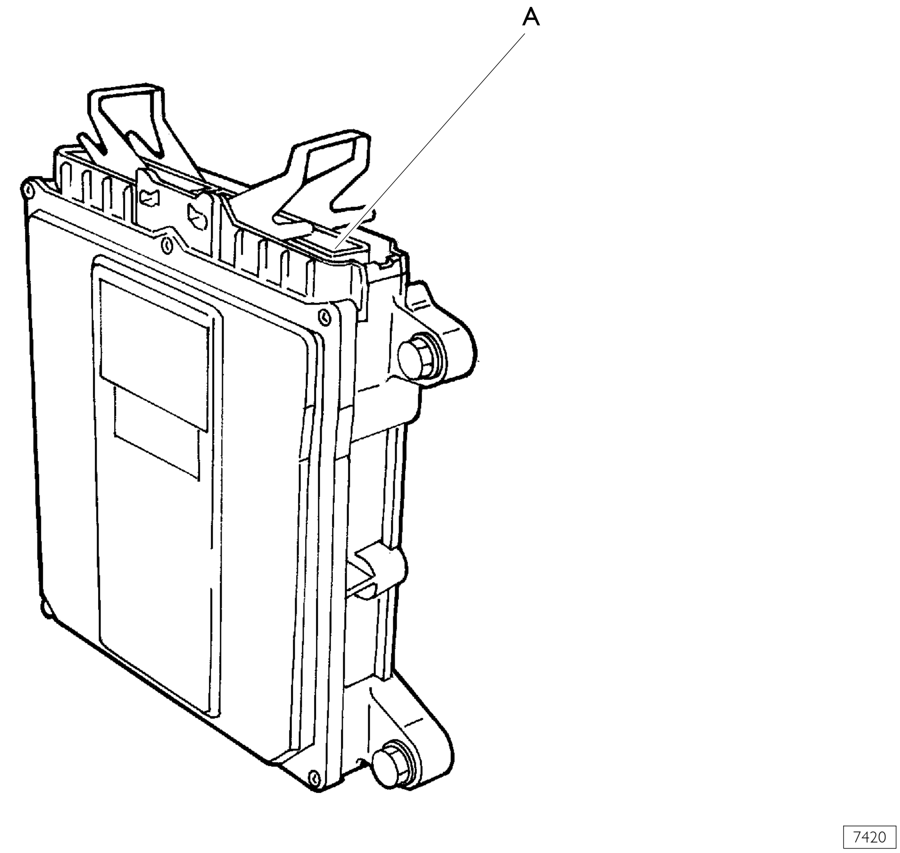
Bosch MS6.3 control unit

Figure 3

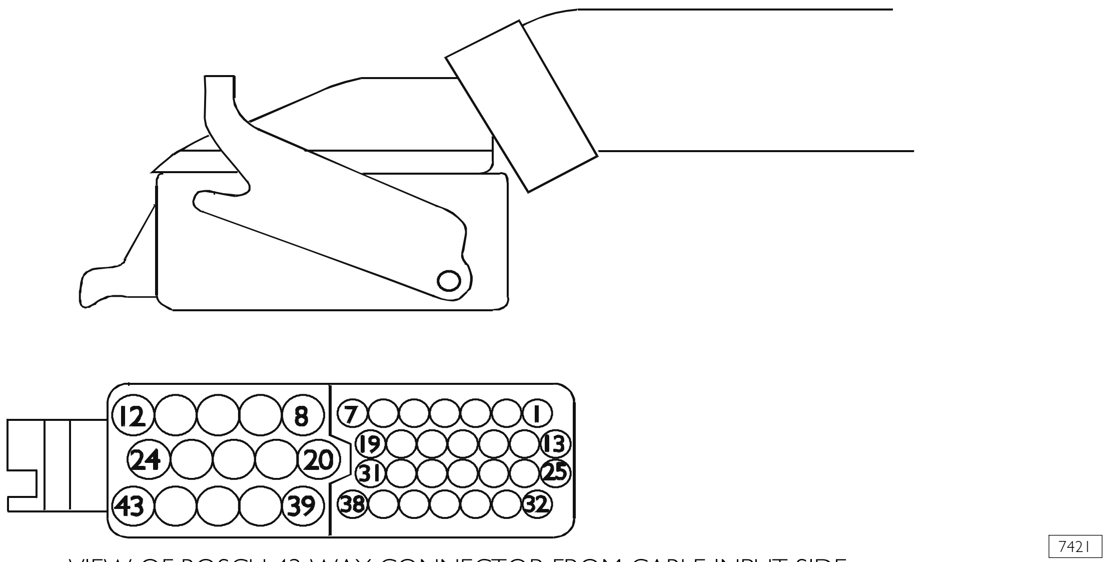
85150



PERSPECTIVE VIEW
A. Housing for injection cable connector - B. Seat for cabin-bonnet cable (UNIJET motor drive)

Control unit connection to the injection cable on engine side (housing A) (EDC MS 6.3)

Figure 4

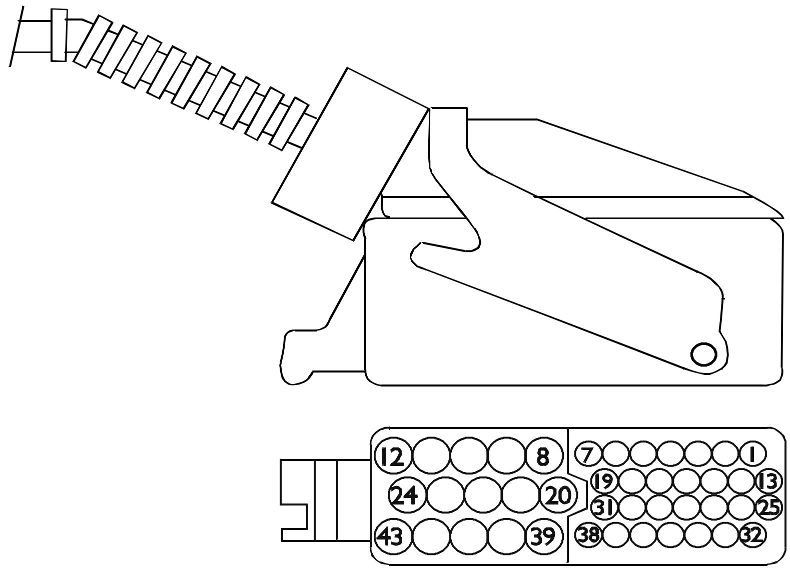


VIEW OF BOSCH 43-WAY CONNECTOR FROM CABLE INPUT SIDE

Pin	Function	Cable colour code
1	To engine coolant temperature sensor	5154
2	To turbo-blower air pressure and temperature sensor for EDC (without EGR)	5151
3	To turbo-blower air pressure and temperature sensor for EDC (without EGR)	5153
4	To engine rpm sensor on camshaft (cams)	White
5	To temperature sensor and ambient air pressure for EDC (with EGR)	5151
6	Fuel pressure adjustment sensor earth	0000
7	Control to relay for switching on fuel pump	8150
8	Common EDC centre mass – Centre monitored remote control switches - EGR electro valve	0000
9	To solenoid valve for pressure adjustment	9925
10	To solenoid valve for electronic injection (injector 2 - cylinder 3)	—
11	Spare	—
12	To solenoid valve for electronic injection (injector 1 - cylinder 1)	—
13	To solenoid valve for pressure adjustment	5590
14	Spare	—
15	Sensor (fuel temperature) for switching on fuel warming	5592
16	Spare	—
17	To ambient air temperature and pressure sensor for EDC (with EGR)	8150
18	To ambient air temperature and pressure sensor for EDC (with EGR)	8151
19	Air temperature and pressure sensor earth (without EGR)	0165
20	Solenoid valve earth for pressure regulator	0000
21	Spare	—
22	Spare	—
23	To solenoid valve for electronic injection (injector 3 - cylinder 4)	—
24	To solenoid valve for electronic injection (injector 4 - cylinder 2)	—
25	To solenoid valve controlling anti-pollution system (with EGR, if present)	5577
26	To ambient air temperature and pressure sensor for EDC (with EGR, if present)	8152
27	To speed limiter adjustment sensor	8847
28	To ambient air temperature and pressure sensor for EDC (with EGR, if present)	8153
29	To sensor for engine rpm	White
30	Earth shared by control unit and temperature sensors	0150
31	To engine rpm sensor on camshaft (cams)	Black
32	Control to relay for heated fuel oil filter	8159
33	To sensor for fuel pressure adjustment	5591
34	To turbo-blower air pressure and temperature sensor for EDC (without EGR)	5152
35	Control to relay for engaging conditioner compressor	9990
36	Spare	5000
37	To engine rpm sensor	Black
38	Spare	-
39	Control to relay for engine cooling joint	7740
40	To solenoid valve for electronic injection (injector 1 - cylinder 1)	—
41	To solenoid valve for electronic injection (injector 4 - cylinder 2)	—
42	To solenoid valve for electronic injection (injector 3 - cylinder 4)	—
43	To solenoid valve for electronic injection (injector 2 - cylinder 3)	—

Control unit connection to cab-bonnet cable (housing B) (EDC MS 6.3)

Figure 5



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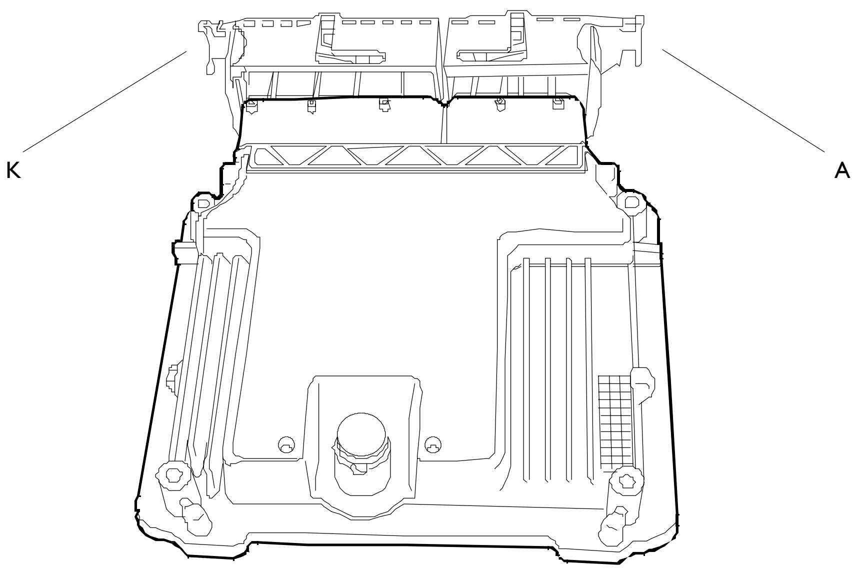
VIEW OF BOSCH 43-WAY CONNECTOR FROM CABLE INPUT SIDE

Pin	Function	Cable colour code
1	To cruise Control (if present)	8156
2	To load sensor on accelerator for EDC	5157
3	Spare	—
4	To instrument panel module A1 rpm indicator repeater (if present)	5155
5	Spare	—
6	Compressor engaged signal to EDC (if present)	8162
7	To diagnostic socket	2299
8	To alarm control unit (if present)	Green
9	EDC control unit supply	8150
10	EDC control unit supply	8150
11	Spare	0000
12	To earth signal (battery negative)	0000
13	To load sensor on accelerator for EDC	5156
14	Instrument panel module A20 rpm indicator repeater mass (if present)	0000
15	Spare	—
16	To instrument panel module A17 rpm signal (if present)	5614
17	Spare	—
18	Spare	—
19	To diagnostic socket	1199
20	To key-operated fuse 2	8051
21	To instrument panel module Al A30 engine preheat warning leds (if present)	0000
22	EDC control unit supply	8150
23	To instrument panel module Al EDC A29 defect warning leds (if present)	5156
24	To earth signal (battery negative)	0000
25	To Cruise Control (if present)	8155
26	Supply with stop lights on	8153
27	To load sensor on accelerator for EDC	0150
28	To diagnostic socket	9932
29	To load sensor on accelerator for EDC	0159
30	Spare	—
31	Supply when brake pedal is pressed	8158
32	To cruise Control (if present)	8154
33	To cruise Control (if present)	8157
34	Spare	—
35	To load sensor on accelerator for EDC	5158
36	Spare	—
37	F1A preheat centre control	1310
38	To clutch pressed signal relay for EDC	0160
39	To alarm control unit (if present)	White
40	Control to relay for EDC engagement	8150
41	EDC control unit supply	8150
42	Preheat centre control	0000 / 1311
43	To earth signal (battery negative)	0000

Bosch EDC16 control unit

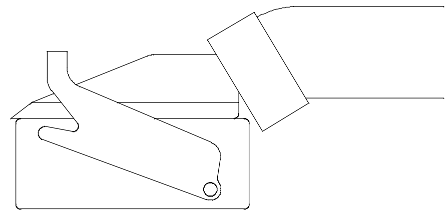
Figure 6

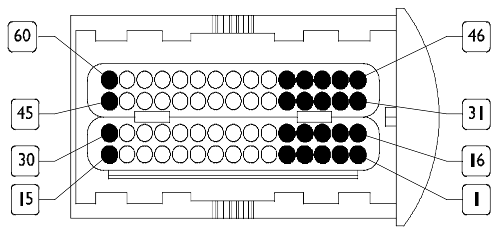


PERSPECTIVE VIEW
A. Engine side injection cable connector - K. Bonnet/cab cable connector

EDC 16 control unit connection to the injection cable on engine side (housing A)

Figure 7





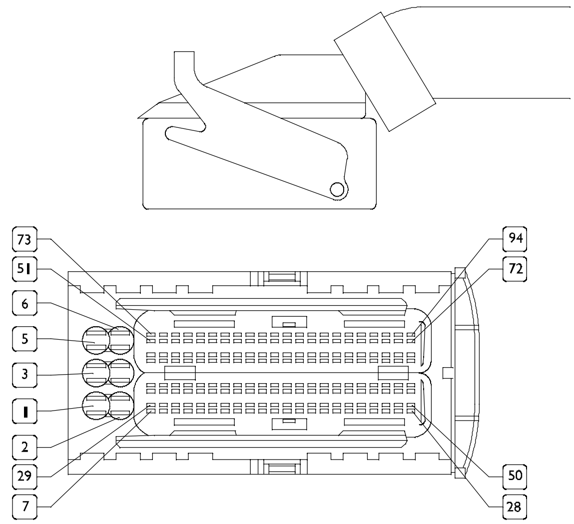
Pin	Cable colour code	Function
1	0000	Cylinder injector 3
2	0000	Cylinder injector 2
8	0000	Rail pressure sensor negative
11	0174	Distributing shaft sensor negative (phase)
12	red	Drive shaft sensor
13	5153*	Boosting air pressure and temperature sensor power supply
16	9924	Cylinder injector 1
17	9924	Cylinder injector 4
19	0000	Pressure regulator negative
20	7158	Distributing shaft sensor positive
21	–	Drive shaft sensor braided wire
23	0165*	Boosting air pressure and temperature sensor negative
27	white	Drive shaft sensor
28	5591	Rail sensor power supply
29	8152	Air flow meter power supply (available with EGR)
31	9924	Cylinder injector 2
33	0000	Cylinder injector 4
37	5151	Air flow meter air temperature signal (available with EGR)
40	5152*	Boosting air pressure sensor signal
41	0150	Water temperature sensor negative
42	8153	Air flow meter signal (available with EGR)
43	5591	Rail pressure signal
44	8151	Air flow meter negative (available with EGR)
46	9924	Cylinder injector 3
47	0000	Cylinder injector 1
49	9925	Pressure regulator
50	9160	Distributing shaft sensor signal (phase)
51	0150	Fuel temperature sensor negative

Pin	Cable colour code	Function
52	**5592**	Fuel temperature sensor signal
53	**5151***	Boosting air temperature sensor signal
58	**5154**	Water temperature sensor signal
60	**8150**	EGR solenoid valve (if present)

●	Power seats
○	Signal seats
(*)	Available when the EGR is not provided
-	Pins not highlighted are not used

EDC 16 control unit connection to cab-bonnet cable (housing K)

Figure 8



85708

85709

Pin	Cable colour code	Function
1	-	+30 (main relay)
2	0000	Earth
4	0000	Earth
5	8150	+30 (main relay)
6	0000	Earth
8	0150	Accelerator pedal sensor negative (pin 5)
9	5157	Accelerator pedal sensor signal (pin 4)
13	-	Signal from power takeoff (if any) state selector
16	-	Negative from power takeoff (if any) state selector
17	-	Signal from brake pedal pressed for stop light ignition
25	2299	K line
28	8051	+15
30	0159	Accelerator pedal sensor negative (pin 3)
31	5157	Accelerator pedal sensor signal (pin 6)
38	8155	Cruise Control (resume) (where available)
42	-	Speed limiter button
45	5158	Accelerator pedal sensor power supply (pin 2)
46	5158	Accelerator pedal sensor power supply (pin 1)
48	5614	Engine speed sensor (revs counter)
52	1310	To preheating spark plug actuation remote-control switch pin D1
54	8162	Signal from air-conditioning ON compressor remote-control switch
56	8157	Cruise Control (set +) (where available)
57	-	Auxiliary speed limiter (where available)
58	-	Signal from clutch switch
61	-	CAN L line
62	-	CAN H line
68	8150	Fuel filter heating remote-control switch positive

Pin	Cable colour code	Function
70	**9990**	Positive to the remote-control switch for engine water recirculation shut-off solenoid valve control with auxiliary heater ON
71	**5156**	EDC warning light negative
72	**8150**	Main relay (negative)
75	**5155**	Vehicle speed signal (tachometer)
77	**8154**	Cruise Control (off) (where available)
78	**8156**	Cruise Control (set -) (where available)
80	**8158**	Brake pedal signal
90	**7740**	Positive for engine cooling electromagnetic joint control (where available)
91	**-**	Fuel electric pump remote-control switch negative
92	**0000**	Pre-heating warning light negative
93	**1311**	To pre-heating spark plug actuation remote-control switch pin ST
-	Pins not highlighted are not used	

EDC system main components

Ref.	Component code	Description
1	58918	Instrument panel tachometer
2	58918	Instrument panel rev counter
3	42374	Clutch pedal switch
4	53565	Brake pedal switch
5	85152	Idling switch and accelerator pedal position sensor
6	47106	Fuel temperature sensor
7	47106	Fuel temperature sensor Fuel filter clogging sensor
8	85157	Fuel pressure sensor
9	47035	Coolant temperature sensor
10	85156	Air delivery sensor
11	48042	Distribution sensor
12	48035	Crankshaft sensor
13	78247	Electro injectors
14	25231	Plug preheat centre
15	19010	Preheat plug
16	85151	Fuel electro pump
17	78013	Pressure regulator
18	12012	AC compressor (if present)
19	78209	EGR modulating electro valve (if present)
20	85159	Air delivery sensor
21	58701	EDC warning light
22	58702	Preheat warning light
23	54032	Cruise Control/PTO controls (if present)
24	85130	Start key with Immobilizerv (if present)
25	72027	Diagnosis connection
26	85022	Fan electromagnetic connection (if present)
(*)	On version without EGR	
(**)	On version with EGR	

Figure 9

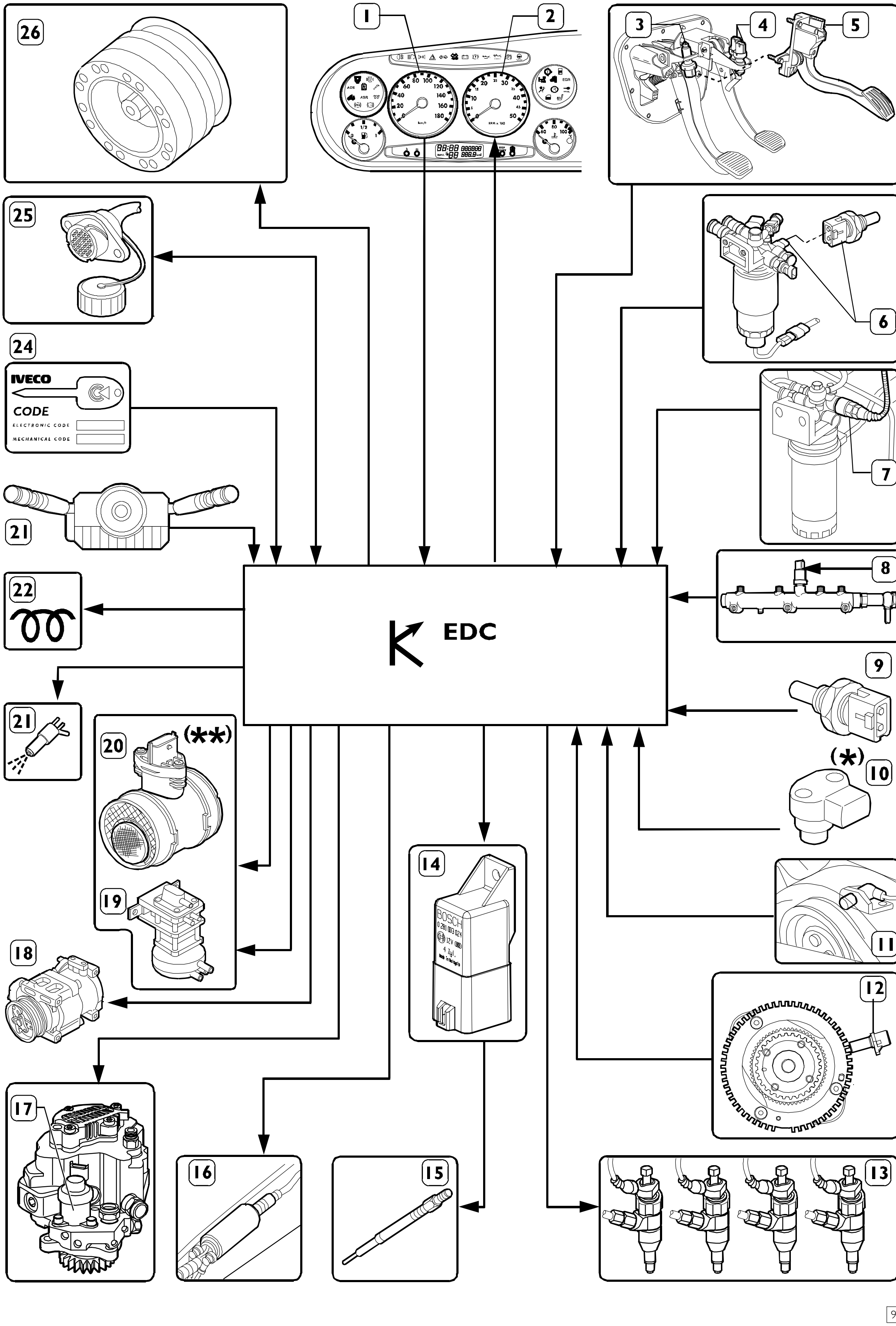
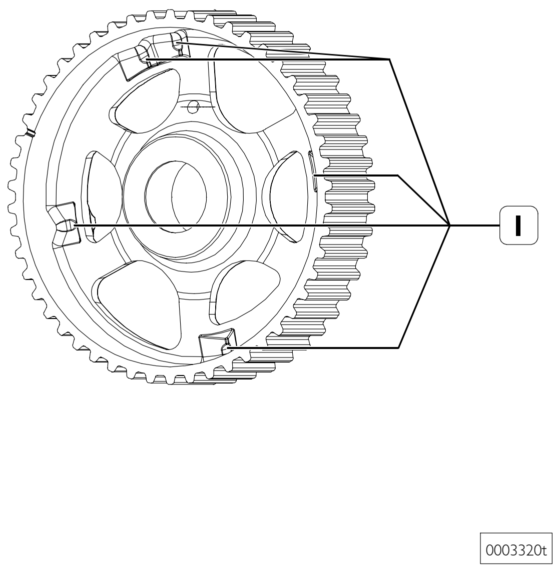
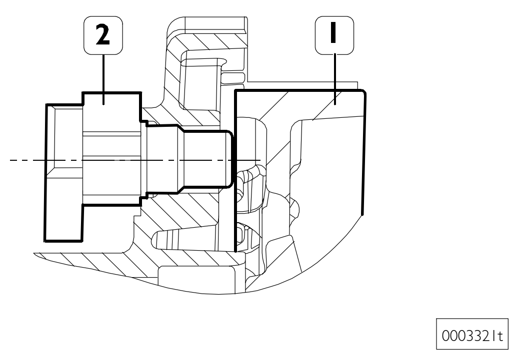

1
2
3
4
5
6
7
8
9
(*)
10
11
12
13
14
15
16
17
18
19
20
(**)
21
22
24
IVECO
CODE
25
26
EDC
BOSCH
99149

Figure 10



1. Phase identification holes

Figure 11



1. Distributing shaft pulley - 2. Sensor

Camshaft sensor

A semiconductor layer, immersed in a magnetic field and through which current flows, generates a potential difference (called Hall voltage) at its ends.

If current intensity remains constant, the generated voltage depends only on the magnetic field strength: periodical variation of field strength is enough to obtain a modulated electric signal.

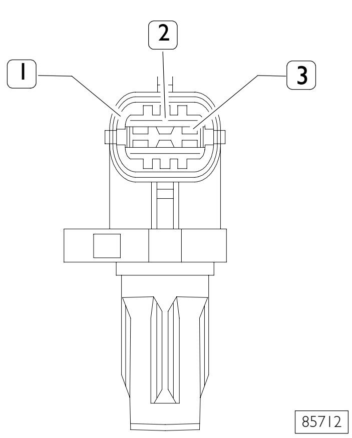
The smooth portion of the phonic wheel (distributing shaft pulley) covers, while moving, the sensor, thus blocking the magnetic field with resulting low output signal.

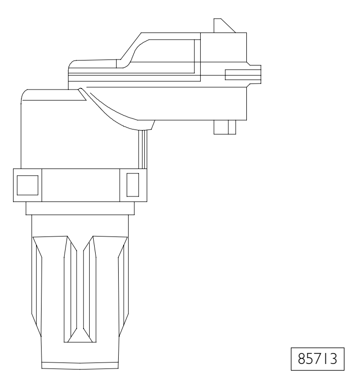
On the contrary, the sensor generates a high signal next to the openings and when a magnetic field is available.

Phase sensor signals are acquired, and the engine position is recognized according to the sequence of the phonic wheel notches.

The mounting function makes it possible to identify signal errors and interferences (if any).

Figure 12





PERSPECTIVE VIEW
1. Power supply positive - 2. Signal output - 3. Earth

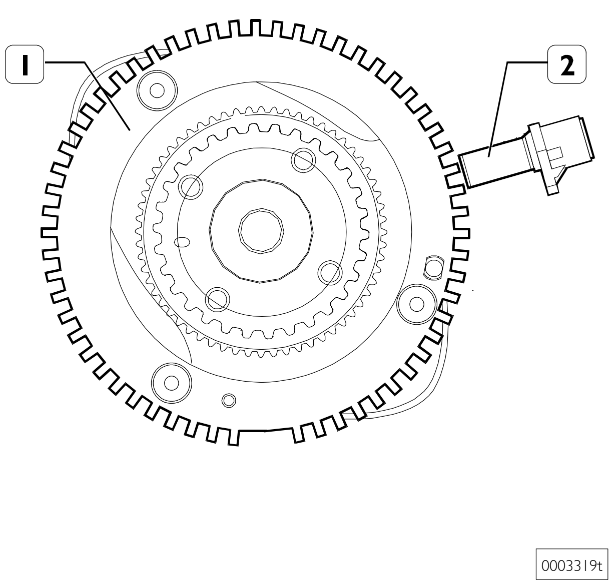
RPM sensor

A phonic wheel is fitted on the drive shaft. As the sensor detects existing teeth passing, it provides the central unit with the signal that is necessary to determine engine r.p.m.'s.

The variation of the signal generated by the lack of some teeth (synchronisation gap) occurring at each drive shaft turn is the reference signal which enables the central unit to detect the lead of the pair of pistons 1-4 with respect to PMS.

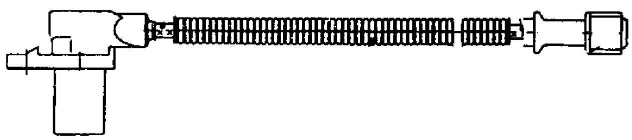
This signal is also used by the control unit to detect the engine rotation speed, the duration of injection and to control the rev counter.

Figure 13



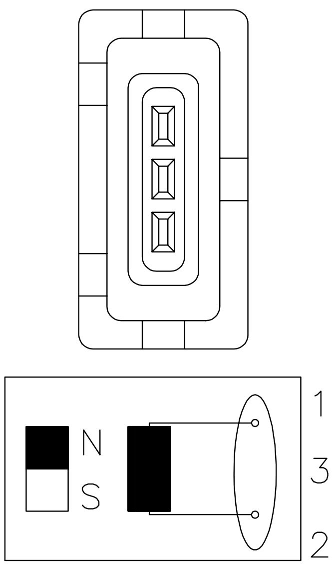
TECHNICAL VIEW OF THE SOUND WHEEL AND SENSOR
1. Sound wheel - 2. Sensor

Figure 14



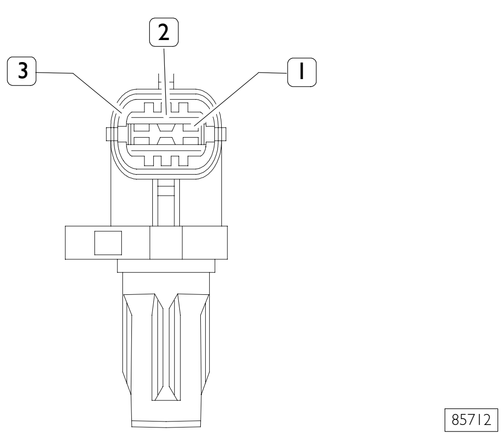
RPM SENSOR AND CONNECTION CABLE

Figure 15



SENSOR CONNECTOR AND WIRING DIRAGRAM

Figure 16



TIMING SENSOR
1. Earth - 2. Signal output - 3. Power supply positive

RPM sensor

These are inductive sensors.

Flywheel sensor (48035) is connected to pins 27 and 12 of connector A of central unit EDC 16 and to pins 29 and 37 of connector A of central unit MS 6.3.

Timing sensor

A semiconductor layer, immersed in a magnetic field and through which current flows, generates a potential difference (called Hall voltage) at its ends.

If current intensity remains constant, the generated voltage depends only on the magnetic field strength: periodical variation of field strength is enough to obtain a modulated electric signal.

The smooth portion of the phonic wheel (distributing shaft pulley) covers, while moving, the sensor, thus blocking the magnetic field with resulting low output signal.

On the contrary, the sensor generates a high signal next to the openings and when a magnetic field is available.

Phase sensor signals are acquired, and the engine position is recognized according to the sequence of the phonic wheel notches.

The mounting function makes it possible to identify signal errors and interferences (if any).

The resulting signal is supplied to the processor that controls the injection system.

Sensor (48042) is connected to central unit (EDC 16) and pins 4/31 of connector A of central unit EDC MS 6.3.

Pressure regulator

It is mounted on the low pressure circuit of pump CP3.

When the engine control centre pilots the pressure regulator via the PWM signal, solenoid (1) is activated, which in its turn generates movement of magnetic core (2).

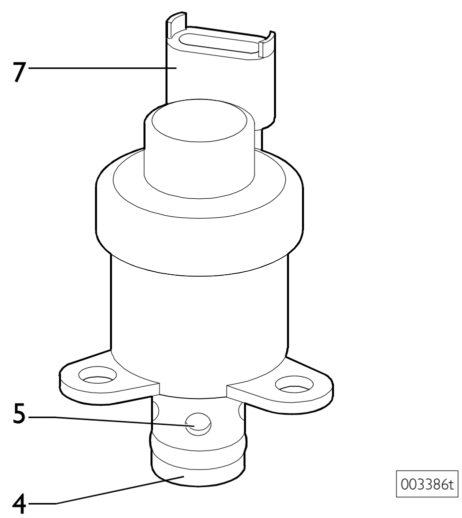
Core movement causes cylinder (3) axial displacement by fuel delivery partialization.

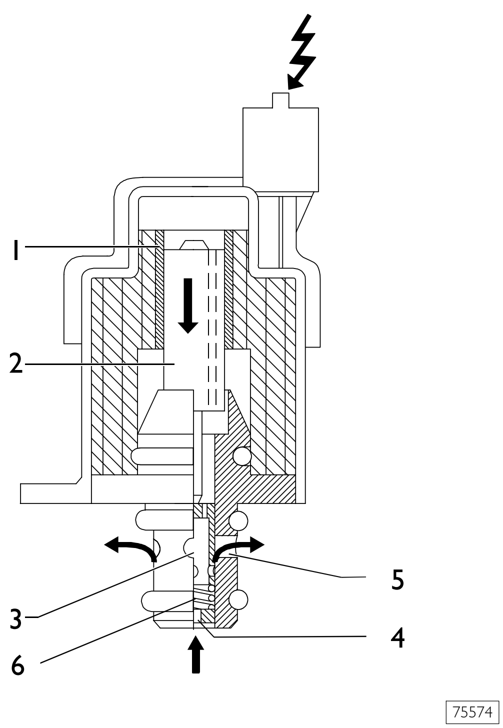
When solenoid (1) is not activated, the magnetic core is moved to its rest position by preload spring (6).

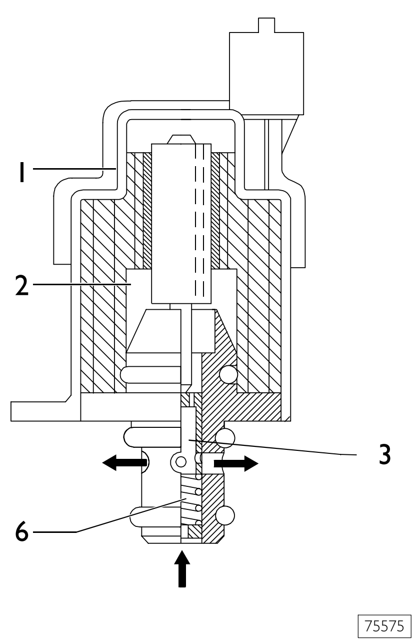
In these conditions, cylinder (3) is in a position to offer maximum fuel passage cross-section.

Drive solenoid valve (78013) is connected to pins 9 and 20 of connector A of central unit EDC MS 6.3 and to pins 19 and 49 of connector A of central unit EDC 16.

Figure 17







1. Solenoid - 2. Magnetic core - 3. Cylinder - 4. Fuel input - 5. Fuel output - 6. Preloiad spring - 7. Connector

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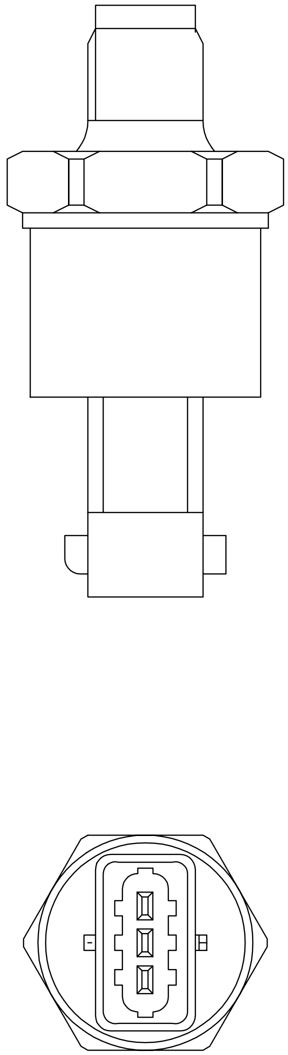
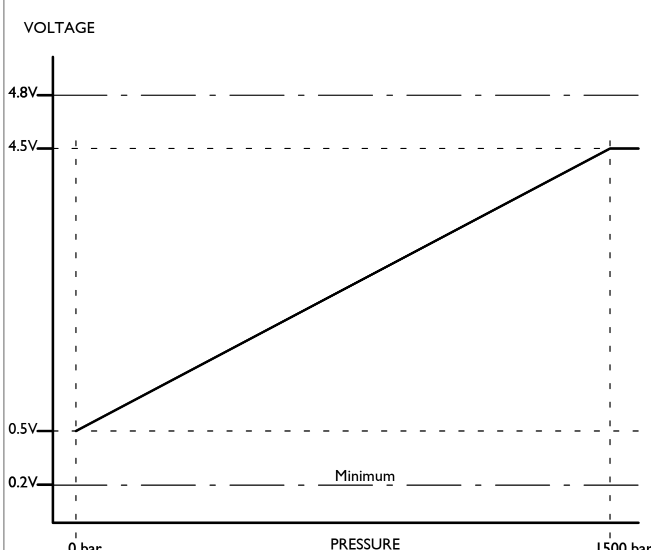
Figure 18



TECHNICAL VIEW OF COMPONENT AND LIMITER CONNECTOR

Figure 19



PRESSURE LIMITER OPERATING GRAPH

Fuel pressure sensor

This is fitted at the centre of the rail and measures the existing fuel pressure in order to determine the injection pressure.

The injection pressure value is used as feedback for closed loop pressure control and to determine the duration of the electric command for injection.

It is connected to pins 6, 13 and 33 of connector A of central unit EDC MS 6.3 and to pins 8, 28, 43 of connector A of central unit EDC 16.

It is supplied at 5 Volt.

Injectors (78247)

The solenoid valve is of the N.C. type.

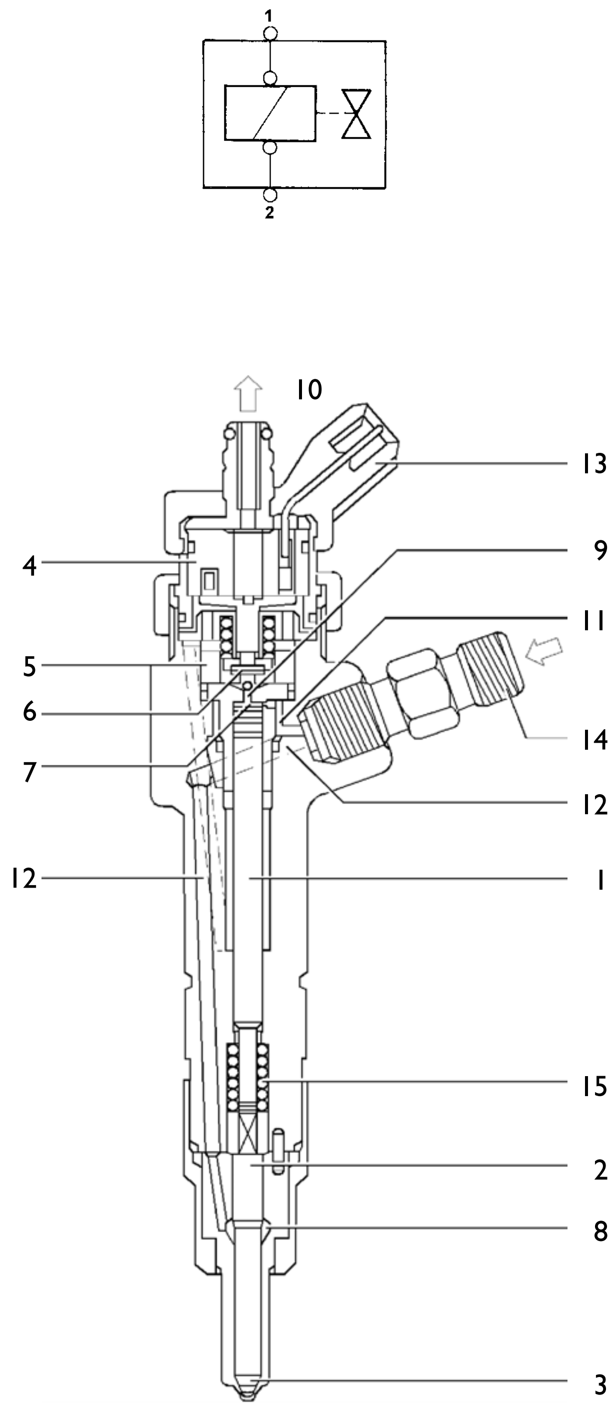
Electric injectors are individually connected to central unit EDC MS 6.3 between the pins:

- A12 / A40 cylinder 1 injector
- A10 / A43 cylinder 2 injector
- A23 / A42 cylinder 3 injector
- A12 / A40 cylinder 1 injector

while for central unit EDC 16:

- A16 / A47 cylinder 1 injector
- A2 / A31 cylinder 2 injector
- A1 / A46 cylinder 3 injector
- A17 / A33 cylinder 1 injector

Figure 20



INJECTOR WIRING DIAGRAM AND CROSS SECTION
1. Pressure rod - 2. Needle - 3. Nozzle - 4. Coil - 5. Pilot valve - 6. Ball shutter - 7. Control area - 8. Pressure chamber - 9. Control volume - 10. Backflow duct - 11. Control duct - 12. Supply duct - 13. Electrical connection - 14. High pressure fuel inlet - 15. Spring

Air flow meter (without EGR)

This component incorporates a temperature sensor and a pressure sensor.

It is fitted on the engine intake manifold and measures the maximum flow rate of the intake air which is used to accurately calculate the amount of fuel to be injected at each cycle.

It is connected to the central unit on pins A2 / A3 / A19 / A34 of central unit EDC MS 6.3 and on pins A13, A23, A40 and A53 of central unit EDC 16.

Pin 1 sensor - Pin A19/A23 ECU	-	earth -
Pin 2 sensor - Pin A2/A53 ECU	-	temperature signal
Pin 3 sensor - Pin A3/A13 ECU	-	5V - supply
Pin 4 sensor - Pin A34/A40 ECU	-	0 ÷ 5V pressure signal -

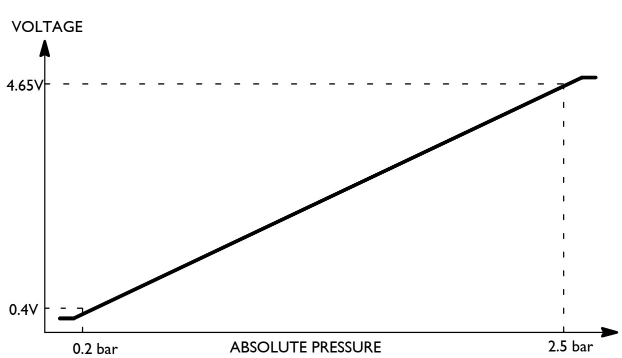
Course of sensor in relation to the temperature:

Temperature	Resistance
- 40 °C	48.50 kOhm
- 20 °C	15.67 kOhm
0 °C	5.86 kOhm
20 °C	2.50 kOhm
40 °C	1.17 kOhm
60 °C	0.59 kOhm
80 °C	0.32 kOhm
100 °C	0.18 kOhm
120 °C	0.11 kOhm

Course of sensor in relation to the pressure:

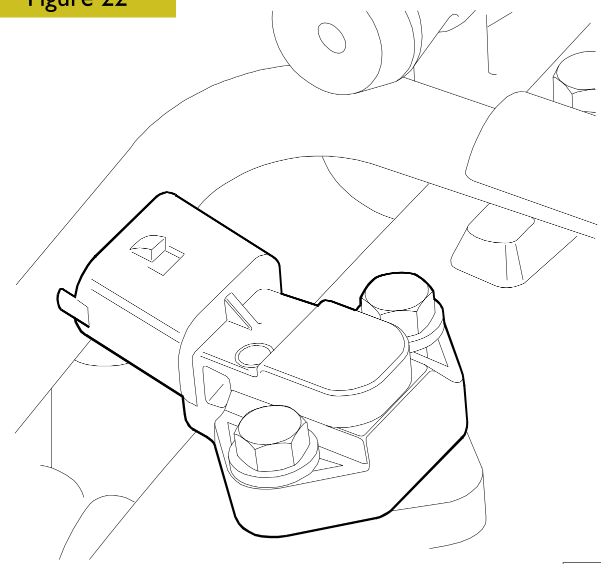
See graph opposite.

Figure 21



AIR FLOW METER OPERATING GRAPH

Figure 22



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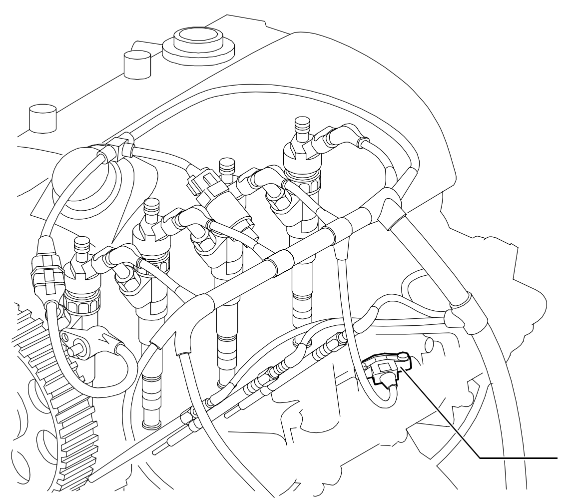
AIR FLOW METER

Figure 23



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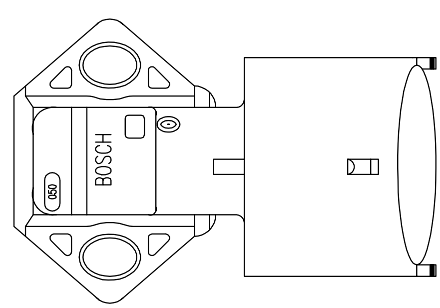
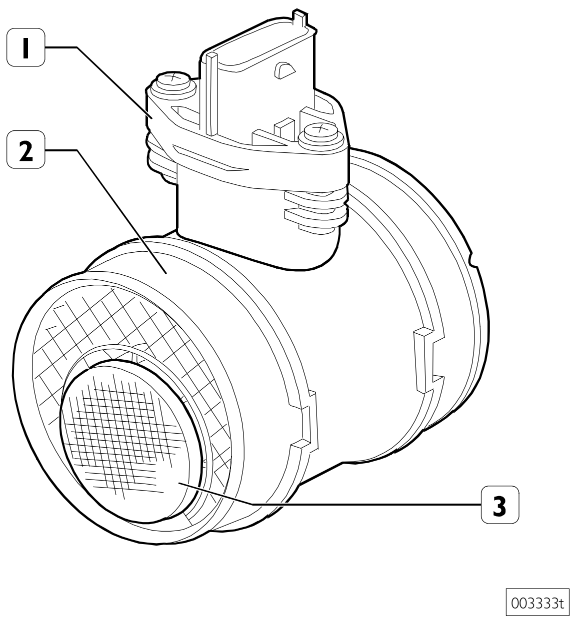
1. Air flow meter location

Figure 24



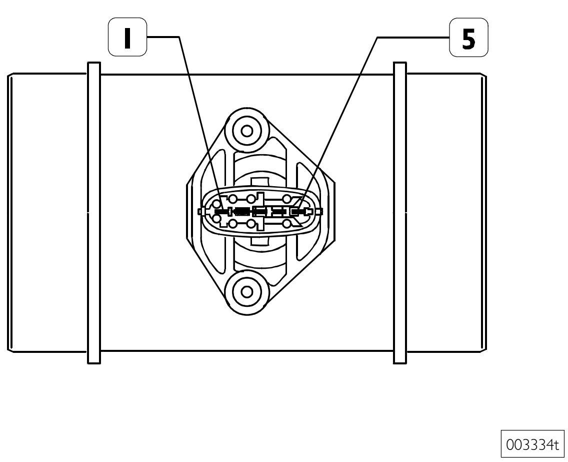
AIR FLOW METER CONNECTION

Figure 25



1. Connector - 2. Gauge body - 3. Air input grid

Figure 26



TECHNICAL VIEW OF GAUGE CONNECTOR

Air flow rate meter (flowmeter) with EGR present

Used in the EGR version to replace the one mounted on the engine aspiration manifold.

The gauge is of the heated film type and is located o their aspiration conduit between the turbine and the air filter.

The gauge contains the aspired air temperature sensor.

It is connected to central unit EDC on pins A5 / A17 / A18 / A26 / A28 for central unit EDC MS 6.3 and on pins A29 / A37 / A44 / A42 of central unit EDC 16.

Pin 1 sensor - Pin A5/A37 ECU	-	temperature signal
Pin 2 sensor - Pin A17 ECU	-	5V power supply (EDC MS 6.3 only)
Pin 3 sensor - Pin A18/A44 ECU	-	mass
Pin 4 sensor - Pin A26/A29 ECU	-	reference voltage
Pin 5 sensor - Pin A28/A42 ECU	-	pressure signal

Flowmeter external feed, when central unit EDC 16 is present, is taken on pin 2 from locked system +15.

The operating principle is based on a heated membrane inserted in a measurement canal through which air to the engine flows.

The hot film membrane is kept at a constant temperature some 120 °C above incoming air level by the heating resistor.

The air mass traversing the measurement canal tends to subtract heat from the membrane so current must cross the resistor to maintain constant film temperature.

Current absorbed is proportional to the air mass flowing to the engine and is measured with a Wheatstone bridge and the signal is forwarded to the electronic centre.

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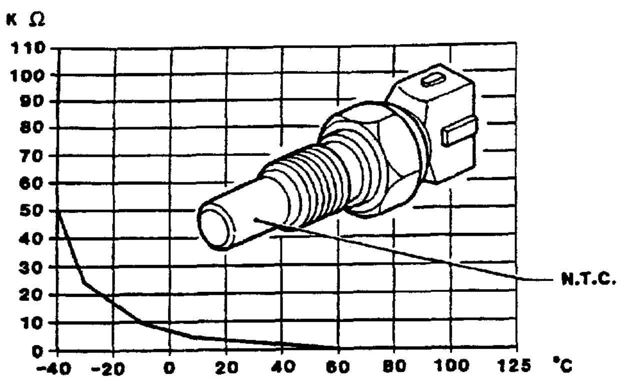
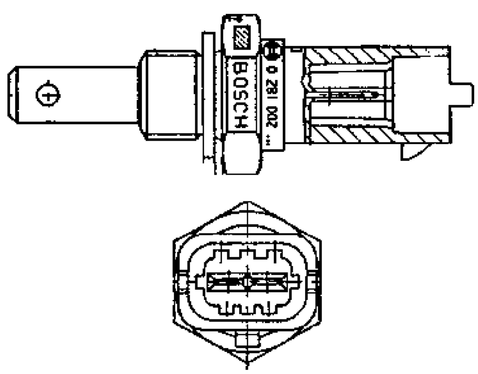
Figure 27



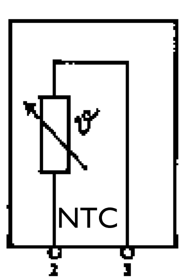
COURSE OF SENSOR RESISTANCE IN RELATION TO TEMPERATURE

Figure 28



TECHNICAL VIEW OF ENGINE COOLANT TEMPERATURE SENSOR

Figure 29



WIRING DIAGRAM

Atmospheric pressure sensor

This is integrated inside the control unit.

It measures the atmospheric pressure to correct the flow rate in relation to the altitude.

Engine coolant temperature sensor

This is an NTC sensor located on the thermostat box.

It detects the temperature of the coolant fluid to give the control unit information about the engine temperature conditions.

It is connected to pins 1 and 30 of connector A of central unit EDC MS 6.3 and to pins 58 and 41 of connector A of central unit EDC 16.

Course of the sensor in relation to the temperature:

Temperature	Resistance
- 40°C	48.30 kOhm
- 20°C	15.46 kOhm
0°C	5.89 kOhm
20°C	2.50 kOhm
40°C	1.17 kOhm
60°C	0.59 kOhm
80°C	0.32 kOhm
100°C	0.19 kOhm
120°C	0.11 kOhm

Fuel temperature sensor

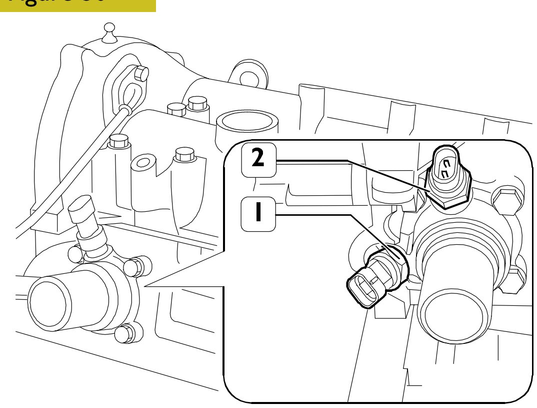
This is an NTC sensor located on the fuel filter.

It detects the temperature of the fuel to give the control unit information about the fuel oil temperature conditions.

It is connected to pins 15 and 30 of connector A of central unit MS 6.3 and to pins 51 and 52 of connector A of central unit EDC 16.

It is exactly the same as the engine coolant temperature sensor.

Figure 30



003324t

LOCATION OF F1A ENGINE COOLANT TEMPERATURE SENSOR
1. EDC - 2. Signal instrument panel signal

Preheat plug electronic centre

EDC central unit effects the timing of the functioning of glow plugs pre-heating central unit depending on engine temperature, which, in turn, activates the glow plugs.

The preheat centre contains an "intelligent" remote control switch that sends a feed-back to the control centre for information on any preheat centre defect or plug earth shirt circuit.

Preheat centre pin-out

31 - Mass

86 - Start switch (+15)

ST - EDC electronic centre (pin B42)

DI - EDC electronic centre (pin B37)

30 - Battery positive (+30)

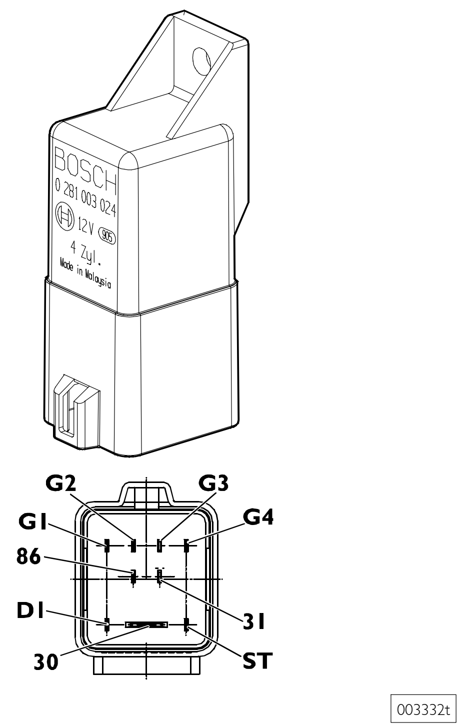
G1 - Preheat plugs

G2 - Preheat plugs

G3 - Preheat plugs

G4 - Preheat plugs

Figure 31



PREHEAT CENTRE

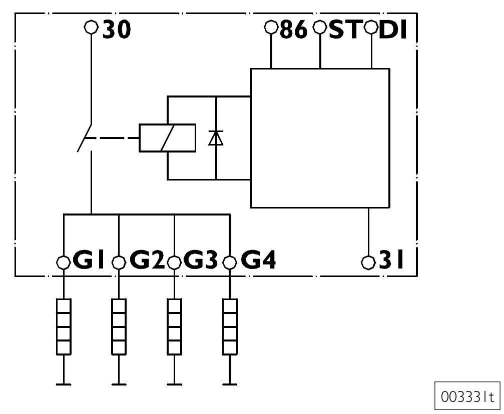
Preheat plugs

CONTROL VALUES

With constant di 11V power supply:

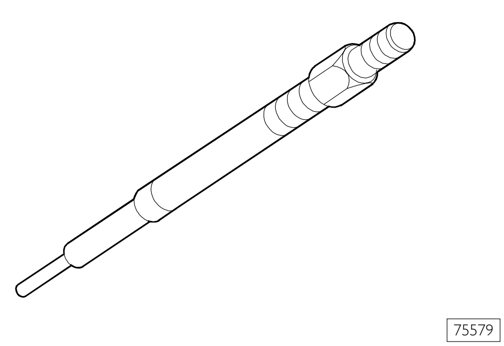
❑ maximum current absorbed	18 A
❑ in 5"	11 ± 1,5 A
❑ in 30"	6 ± 0.9 A
❑ temperature after 7"	850°C
❑ torque	8-10 Nm

Figure 32



ELECTRICAL DIAGRAM

Figure 33



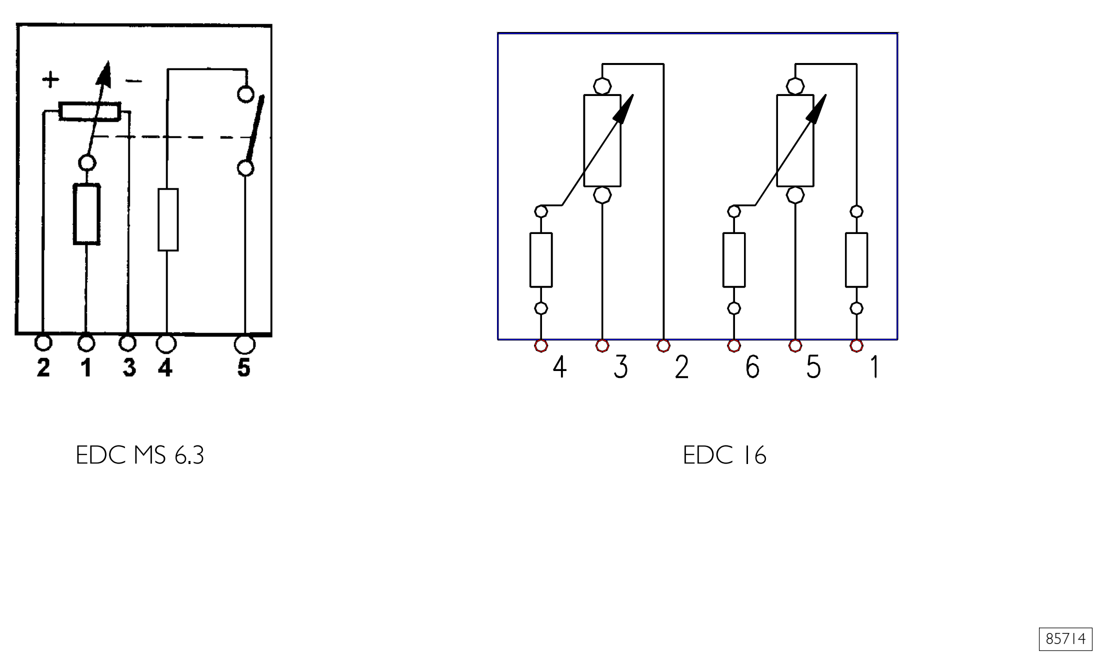
PREHEAT PLUS

Accelerator pedal sensor

A new sensor which incorporates two potentiometers (no idling switch is provided) is available on the accelerator pedal. The ratio between the signals from the two potentiometers is 2:1 (one potentiometer exhibits a twofold resistance value compared with the other). Both of these signals (V) are detected by the control unit that processes them according to stored threshold values and manages the injection system as an accelerator pedal position set by the driver. (At the output of these potentiometers, a variable voltage is available which corresponds to the potentiometer resistance value.)

It is connected for central unit EDC 16 to Pin 9-30-45-31-8-46 of connector K. while for central unit EDC MS 6.3 it is connected to pins 2, 13, 27, 29 and 35 of connector B. The potentiometers are supplied with 5 Volt voltage provided by the central unit itself.

Figure 34

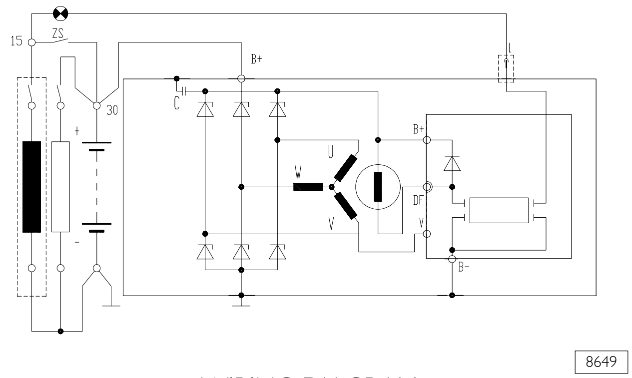


MAIN COMPONENTS OF POWER NETWORK

BOSCH KCBI 14V 110A Alternator

03000

Figure 35



WIRING DIAGRAM

Specifications for use

Vehicle electric system rated voltage:	12 V

Suitable for coupling with battery of any capacity
It must work with the battery connected.

Connection with inverted polarity is not allowed.

Operating specifications

Rated voltage	14 V
Rated current delivery	110A
Drive side direction of rotation	clockwise
Maximum continuous speed	≤ 12.000 min^{-1}
Storage temperature	-40 °C / +110 °C

Figure 36

TECHNICAL VIEW

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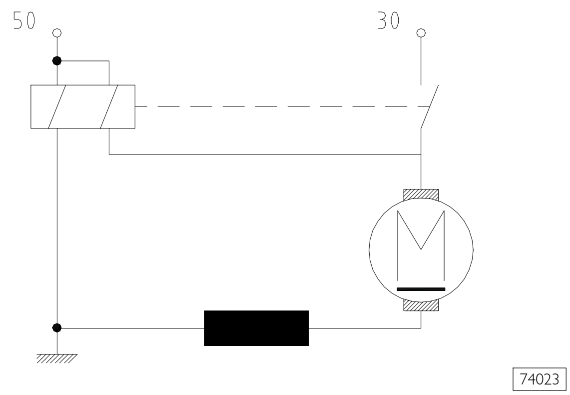
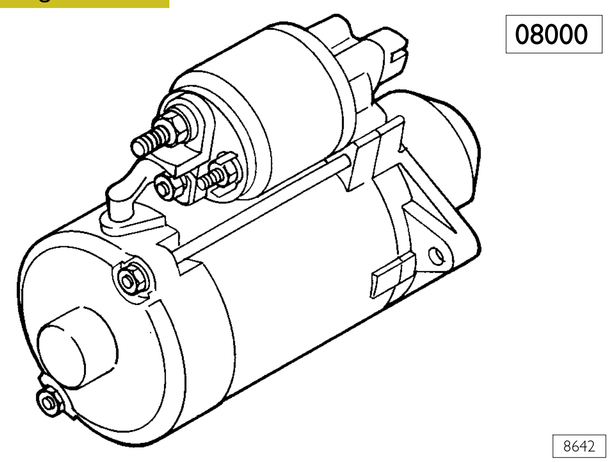
EV 12V - 2.3 kW Starter motor

Figure 37



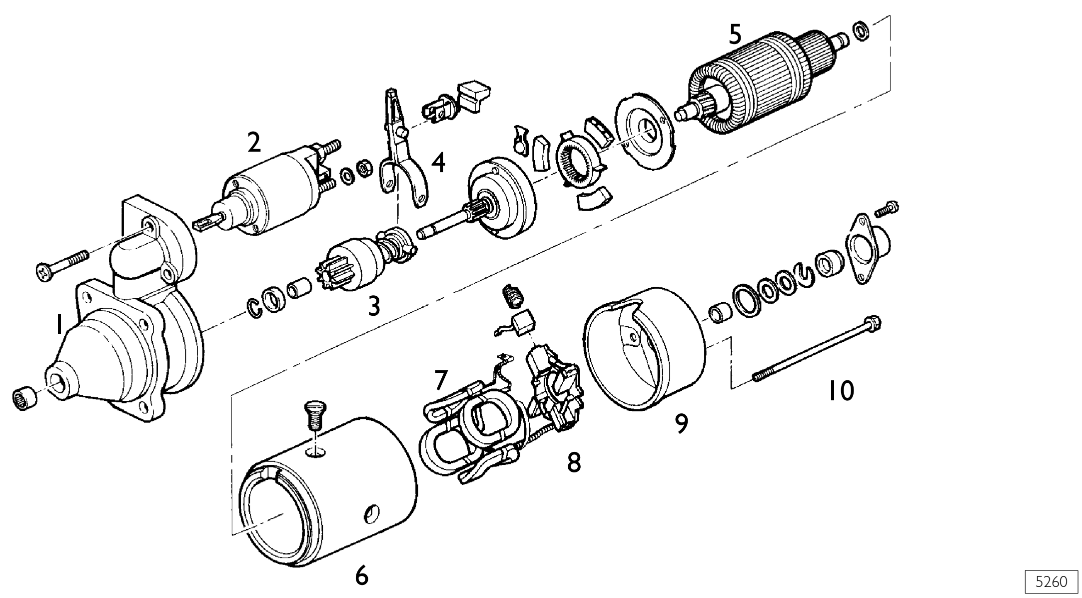
WIRING DIAGRAM

Figure 38



PERSPECTIVE VIEW

Figure 39



PERSPECTIVE BLOWN-UP VIEW
1. Support - 2. Pinion engagement control electromagnet - 3. Pinion - 4. Pinion engament fork - 5. Rotor - 6. Frame - 7. Inductors - 8. Brush holder support - 9. Cover - 10. Screw

Fast diagnosis

Defect	Possible causes	Remedy
Low drawing torque	1. Low battery	Recover
	2. Oxidized or loose circuit connections	Check starter motor and battery connections
	3. Faulty brushes	Check brush slide length and pressure
	4. Field coils short circuited	Replace coils
	5. Rotor cut out or short circuited	Replace rotor
	6. Oval collector	Grind correct or replace
Low drawing torque but engine does not start	1. Defective free wheel or electromagnet	Replace
Pinion disconnected	1. Worn toothed crown	Recover

SYSTEM OPERATION
Self-diagnosis – BLINK CODE

The control unit self-diagnosis system checks the signals from the sensors, comparing them with the admitted limits (see relative heading):

Immobilizer recognition (if present)

When the control unit receives the signal of the key on "MAR" it communicates with the immobilizer control unit to enable starting.

Checking fuel temperature

With the fuel temperature greater than 75°C, detected by the sensor on the fuel filter, the control unit operates the pressure regulator to decrease the line pressure (injection times are not changed). If the temperature exceeds 90°C, the power is reduced to 60%.

Checking engine coolant temperature

The control unit, depending on the temperature:

- of the engine coolant, turbocharging air and fuel, operates the electromagnetic fan (Baruffaldi) and switches on the coolant temperature warning light.

Checking quantity of fuel injected

According to the signals from the sensors and the mapped values, the control unit:

- operates the pressure regulator;
- varies the "pilot" injection time to 2200 rpm;
- varies the "main" injection time.

Checking idling adjustment

The control unit processes the signals from the various sensors and regulates the amount of fuel injected:

- it operates the pressure regulator;
- it varies the injection times of the electro-injectors.

Within certain thresholds the speed takes account of the battery voltage.

Fuel cut-off in release phase

In the phase of releasing the throttle pedal the control unit actuates the following logic elements:

- it cuts off supply to the electro-injectors;
- it partially reactivates supply to the electro-injectors before reaching idling speed;
- it operates the fuel pressure regulator.

Checking cylinder balancing on idling

According to the signals received from the sensors, the control unit controls the regularity of the torque at idling speed:

- it varies the amount of fuel injected into the single electro-injectors (injection time).

Checking regular engine rotation (anti-sawing)

It ensures regular engine rotation at a constant rate while increasing revs.
The control unit processes the signals received from the sensors and determines the amount of fuel to be injected via:

- the pressure regulator;
- the electro-injector opening time.

Checking smokiness at exhaust on acceleration

With heavy acceleration, on the basis of the signals received from the air introduction meter and engine speed sensor, the control unit determines the optimum amount of fuel to inject:

- it operates the pressure regulator;
- it varies the electro-injector injection time.

Checking exhaust gas recirculation (E.G.R. if present)

Depending on the engine load and the signal from the accelerator pedal sensor, the control unit limits the amount of air taken in, actuating partial suction of the exhaust gases.

Checking top speed limit

Depending on the number of revs, the control unit actuates two action strategies:

- at 4250 rpm it cuts off the fuel, decreasing the electro-injector opening time;
- over 5000 rpm it deactivates the electro-injectors.

Checking regular rotation on acceleration

Regular progression is assured in all conditions by the control of the pressure regulator and the electro-injector opening time.

Checking glow plug control unit

The injection control unit, in the phase of:

- starting
- after-starting

times operation of the glow plugs according to the engine temperature.

Checking activation of air-conditioning system

The control unit operates the air-conditioning compressor:

- switching it on/off when the relative switch is pressed;
- momentarily turning it off (approximately 6 sec.) if the engine coolant reaches the set temperature.

Checking fuel pump

Irrespective of the speed, the control unit:

- supplies the auxiliary fuel pump with the key on MAR;
- cuts off auxiliary pump supply if the engine is not started up within a few seconds.

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Checking diesel warming

It times operation of diesel warming in relation to ambient temperature.

Checking cylinder position

During each turn of the engine, the control unit recognizes which cylinder is in the power stroke and operates the injection sequence for the appropriate cylinder.

Checking pilot and main injection timing

According to the signals from the various sensors, including the absolute pressure sensor built into the control unit, the control unit determines the optimum point of injection according to internal mapping.

Checking injection pressure closed cycle

Depending on the engine load, determined by processing the signals from the various sensors, the control unit operates the regulator to obtain optimum line pressure.

Fuel supply

The fuel supply is calculated in relation to:

- accelerator pedal position
- engine speed
- quantity of air introduced.

The outcome may be corrected in relation to:

- the water temperature.

Or to avoid:

- noise
- smoke
- overloading
- overheating
- turbine over-revving.

The delivery can be modified in the case of:

- action of external devices (ABS), ABD, EDB
- serious trouble decreasing the load or stopping the engine.

After determining the mass of air introduced by measuring its volume and temperature, the control unit calculates the corresponding mass of fuel to inject into the relevant cylinder (mg per delivery) also taking into account the temperature of the diesel.
The mass of fuel calculated in this way is first converted into volume (mm^3 per delivery) and then into degrees of throw, or duration of injection.

Correcting flow rate according to water temperature

A cold engine meets with greater resistance during operation: friction is high, the oil is still very viscous, and the various clearances are not yet optimized.
In addition, the injected fuel tends to condense on the metal surfaces that are still cold.
The fuel supply for a cold engine is therefore greater than for a warm one.

Correcting flow rate to avoid noise, smoke or overloading

The behaviour that could lead to this kind of trouble is well known.

The designer has therefore included special instructions in the control unit to avoid it.

De-rating

In the event of the engine overheating, injection is modified, decreasing the delivery to a varying degree, in proportion to the temperature reached by the coolant.

Injection timing electronic test

The advance (start of delivery, expressed in degrees) may be different from one injection to the next, also differentiated from one cylinder to another. It is calculated, similarly to the delivery, in relation to the engine load (accelerator position, engine speed and air introduced).
The advance is appropriately corrected:

- in phases of acceleration;
- according to the water temperature.

And also to obtain:

- lower emissions, noise and overloading;
- better vehicle acceleration.

An extremely high advance is set on starting, depending on the water temperature.
Feedback from the start of delivery is supplied by the change in impedance of the injector solenoid valve.

Speed governor

The electronic speed governor has both features of governors:

- idling and top speed
- all speeds

It is stable in ranges where conventional, mechanical governors are imprecise.

Engine starting

During the first few turns of the engine, the timing and cylinder no. 1 recognition signals (flywheel sensor and camshaft sensor) are synchronized.
The accelerator pedal signal is ignored on starting. Starting delivery is set only according to water temperature, by a special map.
When the control unit detects such speed and acceleration of the flywheel as to be able to consider the engine started up and no longer driven by the starter motor, it re-enables the accelerator pedal.

Cold starting

If even just one of the three temperature sensors (water, air or diesel) records a temperature lower than 10°C, pre-post heating is activated.
When the key makes contact the pre-heating indicator light comes on and stays on for a length of time that varies in relation to the temperature (while the glow plugs in the cylinder head heat the air), then flashes. It is now possible to start up the engine.
When the motor is running this indicator light goes out, while the glow plugs continue to be powered for a certain length of time (variable) for post-heating.
If, with the indicator light flashing, the engine is not started up within 20-25 seconds (inattention time), the operation is cancelled so as not to run down the batteries pointlessly.
The pre-heating curve is also variable in relation to the battery voltage.

Warm starting

If the reference temperatures all exceed 10°C, when the key makes contact the indicator light comes on for approximately 2 sec., for a short test, and then goes out. It is now possible to start up the engine.

Run up

When the key makes contact, the control unit transfers the information stored in memory when the engine was last stopped into the main memory (see After Run) and makes a diagnosis of the system.

After run

Whenever the engine is switched off with the key, the control unit stays powered for a few seconds by the main relay.
This makes it possible for the microprocessor to transfer some data from the main memory (volatile) to a non-volatile memory, which can be erased and written over (EEPROM), so as to make it available at the next start up (see Run Up).

These data basically consist of:

- various settings (engine idling adjustment, etc.);
- settings of some components;
- fault memory.

The process lasts a few seconds, typically from 2 to 7 (depending on the amount of data to save), after which the ECU sends a command to the main relay and makes it disconnect from the battery.

NOTE It is extremely important for this procedure not to be broken off, for example by switching off the engine with the battery cut-out, or by disconnecting the battery cut-out before 10 seconds have passed since switching off the engine.
If this happens, the functioning of the system is ensured, but repeated interruptions may damage the control unit.

Cut-off

This function cuts off fuel delivery when the vehicle is decelerating (accelerator pedal released).

Cylinder balancing

Individual cylinder balancing contributes to increasing comfort and handling.
This function permits individual, customized control over the delivery of fuel and the start of delivery for each cylinder, even differently from one cylinder to another, to compensate for the hydraulic tolerances of the injector.

The differences in flow (delivery specifications) between the various injectors cannot be evaluated directly by the control unit. This information is supplied by Modus reading the bar code of each injector at the time of assembly.

Synchronization search

If there is no signal from the camshaft sensor, the control unit is anyhow able to recognize the cylinders into which the fuel is to be injected.
If this occurs when the engine is already running, the combustion sequence has already been acquired, so the control unit continues with the sequence on which it has already been synchronized.
If this occurs when the machine is at a standstill, the control unit energizes a single solenoid valve. Within at most 2 turns of the crankshaft, injection will take place in that cylinder, so the control unit just needs to get synchronized on the firing sequence and to start up the engine.

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PART THREE - TROUBLESHOOTING

PT-01 PORTABLE TESTER

Using PT-01 with portable tester it is possibile to execute troubleshooting and test the failure memory of the electronic module.

PT-01 has been designed and developed to ensure stoutness and practicality and is particularly suitable to be used in workshop and industrial environment.

The tool is connected to the engine gearbox by means of one only cable providing both tester feed and communication with the electronic module.

Main functions

Before connecting the tester to the electronic module, check the wording on the electronic module to select the correct software on the tool.

1	2	3	4	5	6	7	8	.	A	B	C
u	m	m	k	a	a	*	*	.	v	a	0

a a software 3.3_1
a b software 4.1_2

Easy access to different functions is available through the menu:

- ID. Reading of the electronic module;
- Reading of failure memory and relevant environment conditions;
- Failure memory clear;
- Reading of working parameters;
- Reading of status parameters;
- Active troubleshooting (switching on heat starter, fuel pump, EDC warning led and so on)

Test parameters

- Engine revolutions;
- Spark advance;
- Battery voltage;
- Accelerator foot pedal position;
- Over voltage pressure;
- Over voltage air temperature;
- Cooling liquid temperature;
- Fuel temperature;
- Oil temperature;
- Oil pressure;
- Fuel delivery;
- Fuel pressure;
- Rail pressure duty cycle electro-valve.

1st Section
for engine versions with MS 6.3 ECU

BLINK CODE

Blink-Code	Indicator light	Fault description	Power reduction
VEHICLE			
1.1	On	Vehicle speed (Tachometer)	
1.2		(not used)	
1.3	Off	Cruise Control buttons (Pre-arrangement)	
1.4		Throttle pedal	*
1.5	Off	Clutch switch	
1.6	On	Brake switch	
1.7	Off	Throttle/brake plausibility	Idling
1.8	Off	Main EDC / diagnosis indicator light	
1.9	Off	Air-conditioner control contactor	
ENGINE 1			
2.1	Blinking	Water temperature sensor	*
2.2	Off	Air temperature sensor	
2.3	On	Fuel temperature sensor	
2.4	Blinking	Turbocharging pressure sensor	*
2.5	Off	Atmospheric pressure sensor	
2.7	On	Fuel motor pump control contactor	
2.8	Off	Fuel filter heater control contactor	
2.9	On	Fan control contactor	
ENGINE 2			
3.1	Off	Cylinder 1 balancing	
3.2	Off	Cylinder 2 balancing	
3.3	Off	Cylinder 3 balancing	
3.4	Off	Cylinder 4 balancing	
3.5	Off	Battery voltage	
3.6	Off	Glow plug indicator light	
3.7	Off	Glow plug control contactor	
3.9	Off	Pre-heating monitoring	

	Indicator light	Fault description	Power reduction
ELECTRO-INJECTORS			
5.1	Blinking	Cylinder 1 injector solenoid valve	
5.2	Blinking	Cylinder 2 injector solenoid valve	
5.3	Blinking	Cylinder 3 injector solenoid valve	
5.4	Blinking	Cylinder 4 injector solenoid valve	
5.7	Blinking	Bank 1 (cylinders 1 – 4)	
5.8	Blinking	Bank 2 (cylinders 2 – 3)	
ENGINE SPEED			
6.1	Blinking	Crankshaft sensor	*
6.2	Blinking	Timing sensor	*
6.4	Off	Engine overspeed	
FUEL PRESSURE			
8.1	Blinking	Fuel pressure control	* or cutting out engine
8.2	Blinking	Fuel pressure sensor	*
8.3	Blinking	Pressure regulator solenoid valve	
8.5	On	EGR monitoring	
8.6	On	EGR solenoid valve	
8.7	On	Debimeter	
8.8	Off	Air temperature sensor (debimeter)	
CONTROL UNIT			
9.1	Blinking	Control unit error (Gate array)	* or cutting out engine
9.2		Control unit error (EEPROM)	
9.3	Blinking	EDC – Immobilizer communication	
9.4		Main contactor	
9.5		After run test	
9.6	Blinking	Engine Stop Test (ECU)	
9.7	Blinking	Sensor power supply	* or cutting out engine
9.8	Blinking	Control unit error (Checksum)	Starting not possible
9.9	Blinking	Control unit error (Operating system)	Cutting out engine

(*) Cases when there is a power reduction.

BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
1.1	On	Vehicle speed sensor signal not plausible (circuit may be open or sensor defective).	The speedometer does not work (if the fault is between the sensor and the speedometer). Cruise Control / PTO are not working. (If present)	Read measurable parameters with the diagnostic instrument: when there is this error, the vehicle speed read on the control unit will be fixed on 5 km/h. Read fault memory with the diagnosis instrument: if the error is intermittent, check the connectors for an uncertain contact. If the error is present, perform the following checks: • If the speedometer doesn't work, use a multimeter to check the sensor power supply (12V) between its pin 1 and earth. If supply is correct, check the wiring harness between sensor and instrument panel. • If the speedometer works but indicates an implausible speed, check the sensor is fitted properly, it is clean and its magnetic gap is correct. If the defect persists, check the wiring harness between instrument panel and EDC connector pin B14 and pin B4.	Error detected only with vehicle travelling and only in the event of a short circuit. If signal is not present no error is detected because the control unit considers vehicle to be at a standstill.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
1.4	Blinking	Throttle pedal potentiometer shorted.	Power loss. Engine runs at fast idle speed (1500 rpm) with throttle pedal in rest position. Pressing the pedal causes the engine rpm to increase progressively and uncontrollably up to a reduced top speed (3900 rpm).	Read measurable parameters with the diagnostic instrument to check potentiometer malfunctioning (the signal does not change from 0% to 100%). Check the integrity of the potentiometer (R total = approx. 1 kOhm between pins 4 and 6), check the linear change in resistance of the potentiometer between pins 5 – 6 and 5 – 4 between the minimum and the maximum. If the potentiometer is working correctly, check the wiring between the pedal connector pin 6 and the EDC connector pin B27, between the pedal connector pin 4 and the EDC connector pin B35, between the pedal connector pin 5 and the EDC connector pin B2.	
1.4	Blinking	No signal from the throttle pedal potentiometer (circuit may be open).	Fast idling 1500 rpm in any pedal position.	Check the integrity of the potentiometer. If the potentiometer is sound, check the wiring between the potentiometer and the EDC control unit connector.	

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
1.4	Blinking	Throttle pedal: implausible signal between idling switch and potentiometer.	Fast idling 1500 rpm in idling position and normal acceleration position when pressing the pedal.	Read status parameters with the diagnosis instrument to check the idling switch works properly. If the outcome is negative, use a multimeter on the component to check the integrity of the idling switch (ON-OFF switching between pins 3 and 2 of the pedal connector). If the switch is sound, look for a break in the wiring between the switch pin 2 and EDC connector pin B29, between switch pin 3 and EDC connector pin B13.	(The potentiometer signal is good and indicates the pedal has been released, but the switch status indicates the pedal is pressed.)
1.4	Blinking	Throttle pedal: implausible signal between idling switch and potentiometer.	Idling normal, but on pressing the pedal the engine speed settles on an intermediate fixed value.	Using a multimeter on the component, check the integrity of the potentiometer. If the potentiometer is sound, look for a break or short-circuiting in the wiring between the potentiometer and the connector.	(The potentiometer signal is good and indicates the pedal has been released, but the potentiometer signal indicates the pedal is pressed.)

BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
1.5	Off	Clutch switch: signal not plausible (at the EDC control unit it seems the speed of the vehicle has changed from 0 to at least 30 km/h without the clutch getting pressed) or not present.	Cruise Control / PTO fail to work. (If present)	Read status parameters with the diagnosis instrument to check correct switchover on pressing the pedal. If the result is negative, use a multimeter on the component to check continuity and switchover on pressing the pedal between pins 1 and 2. If the switch is sound, check the continuity of the wiring between switch pin 2 and EDC connector B38. With the key ON, check there is voltage (approx. 12V) between EDC pin B31 and earth.	If everything turns out satisfactory with the check, the trouble could be with not pressing the clutch fully down (it is sometimes possible to change gear without operating the switch).
1.6	On	Brake switch – signals not plausible between primary and secondary.	Brake lights might not work. The Cruise Control / PTO fails to work. (If present)	Read status parameters with the diagnosis instrument to check correct and simultaneous switchover of the primary and secondary brake switches. If the outcome is negative, use a multimeter to check the integrity and correct switchover of the switches (one between pins 3 and 2 and the other between pins 1 and 2). If the switches are sound, with the key ON and the pedal pressed (brake lights on), check for approx. 12V on EDC pin B26 (secondary switch) and on EDC pin B31 (primary switch). If there is no voltage, check the wiring and the relays between the switches and EDC connector.	Check the pedal switches are fitted correctly (they must activate at the same time). If the trouble occurs too frequently, change both switches.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
1.7	Off	Throttle / brake pedal plausibility: simultaneous brake and throttle activation.	Engine speed drops down to idling. If the brake is applied with the throttle pressed, the engine drops down to idling until the brake is released so it is possible to stop the vehicle even if the throttle pedal jams in an intermediate position. Whereas, it is possible to accelerate with the brake pedal pressed without any safety mechanisms tripping.	Read parameters with the diagnosis instrument, check that the throttle pedal potentiometer signal resets on release, otherwise the driver might have pressed the brake and the throttle together.	This error is stored in memory only if the brake and throttle signals are integral. If the error is saved to memory when the pedals are not pressed, it is likely that one of the brake switches is stuck or shorted to +Batt. Make the user aware about using the pedals correctly.
1.8	Off	EDC lamp shorted or circuit open.	The EDC lamp fails to come on when turning the key ON or it stays on even with the key OFF.	Check continuity between the instrument panel pin B17 and EDC connector pin B23. Check that with the key ON there is approx. 12V between the instrument panel pin B16 and earth. Check the LED works between B16 and B17 on the instrument panel. Check continuity between the instrument panel pin B17 and EDC connector pin B23.	The operation of the indicator light is extremely important for the operation and integrity of the system. Make the user aware to check the indicator light works properly with each ignition (if there are no faults in memory, it has to come on for 2 sec. and then go out).

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
1.9	Off	AC compressor control relay coil shorted to +Batt or to earth or circuit open. (If present)	The air-conditioning compressor is not disconnected when the EDC requires it.	Active diagnosis with the diagnostic instrument. If the outcome is negative, check that, with the key ON and engine off, between the EDC pin A35 and earth there is no voltage (if there is also 9.7, call the Help Desk to have the control unit replaced, if necessary). If the compressor does not come off, disconnect compressor drive relay. If, when the relay is disconnected, the compressor stops, replace the relay. If the compressor is never working, try to replace drive relay and check continuity between EDC connector pin A8 and the earth.	If the circuit is open at pin A8 level 2.7-2.8-2.9 are saved to memory as well. The control unit only sees the integrity of the coil between pins 8 – 35 and not any stuck contacts. During active diagnosis, besides the relay tripping the compressor clutch must disconnect-reconnect.
2.1	Blinking	Water temperature sensor short-circuited or circuit open.	Less power (and noise as pre-injection is not implemented) in all cases. Engine cooling fan always on (if there is no temperature signal or it is not valid, in order to protect the engine the control unit turns on the fan).	Read measurable parameters with the diagnosis instrument to check plausibility between EDC water temperature and that signalled by the vehicle's instrument. Read parameters: if there is this error, the water temperature read on the control unit will be the same as that of the fuel. In the event of contrasting indications, use a multimeter to check the integrity of the sensor between its pins 1 and 2 (R = approx. 2.5 kOhm at 20°C). If the sensor is integral, check the wiring between the sensor and EDC connector pin A1-A30.	In the event of trouble with the wiring pin A30, simultaneous signalling of trouble with the fuel temperature sensor and indication (reading measurable parameters) of a fixed temperature of 60°C. In case of high temperature, check engine cooling fan for engagement and check fan drive relay contacts and line protection fuse, if needed.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
2.2	Off	Air temperature sensor on intake manifold short-circuited or circuit open.	The control unit calculates the fuel metering basing itself on a set temperature value. It is therefore possible to have slight decreases or increases in performance and smoke depending on the difference between the substitution temperature and the actual one.	Read measurable parameters with the diagnosis instrument: if there is this error, the turbocharging air temperature will be fixed at 20°C. If the temperature is fixed at 20°C, check the integrity of the sensor (R = approx. 2.5 kOhm at 20°C) pin 1 and 2. If the sensor is sound, check the wiring between the sensor and EDC connector pin A2-A19.	The temperature sensor is integrated with the pressure sensor.
2.3	On	Fuel temperature sensor short-circuited or circuit open.	The control unit calculates the fuel metering basing itself on the water temperature, but in this case there is no reaction the driver can detect.	Read measurable parameters: if there is this error, the fuel temperature will be the same as that of the water. If the temperature indicated has the same value as that of the water, check the integrity of the sensor (R = approx. 2.5 kOhm at 20°C). If the sensor is sound, check the wiring between the sensor and EDC connector pin A15-A30.	In the event of trouble with the wiring pin A30, simultaneous signalling of trouble with the water temperature sensor and indication (reading parameters) of a fixed temperature of 50°C. If the signal exceeds 85°C, reduction to 60% power, if it exceeds 90°C, reduction in injection pressure, if it exceeds 110°C, the error is stored in memory (even if the signal is sound). If the flight recorder reading detects too much time at high temperatures, make the user aware of not driving with the fuel tank level always low.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
2.4	Blinking	Air pressure sensor on intake manifold short-circuited or circuit open. Or waste-gate valve malfunctioning.	Decrease in power. Possible oscillation while driving with engine at full load.	Read measurable parameters with the diagnosis instrument: if there is this error, the value read on the control unit will be fixed on 2000 mbar. If the indicated value is fixed at 2000 mbar, check the wiring between the sensor and EDC connector A3 – A34. If the wiring is sound: Check that the waste-gate valve is not jammed shut or open.	The pressure sensor is integrated with the temperature sensor. If the waste-gate valve is jammed shut, there may be surging with the engine under load because: - power limitation trips when accelerating under load; - the turbocharging pressure drops; - the engine goes back to normal operation and the pressure increases; - limitation trips again; - etc. If the turbocharging pressure really is too high, there is a risk of turbine over-revving with its associated damage.
2.5	Off	Ambient pressure sensor short-circuited or circuit open.	Possibly some black smoke at altitude, especially with EGR (it is not excluded at altitude). (If present)	The sensor is integrated in the EDC control unit and cannot be replaced on its own.	Any painting on the engine/control unit may prevent the ambient pressure getting measured correctly.
2.7	On	Fuel motor pump relay coil short-circuited or circuit open.	Fuel motor pump always on even with key OFF. The battery discharges. Early deterioration of the motor pump. Or The engine starts with difficulty and fails to reach its top performance.	Active diagnosis of the relay with the diagnosis instrument. Take off electric pump drive relay. If the pump cuts out, replace the relay. If the pump does not cut out, check the wiring between 87 of the relay and battery positive. If the motor pump fails to work, check the continuity of the coil between pin A7 and A8 of the EDC connector. In addition, check the wiring between the EDC connector pin A7 and relay 86, EDC connector pin A8 and relay 85.	You hear the noise of the pump turning continuously, even with the key off.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
2.8	Off	Fuel filter heater relay defective.	Heater always on even with fuel temperature > 5°C. The battery discharges.	Active diagnosis of the relay with the diagnosis instrument. Check continuity of the coil between the EDC connector pin A32 and relay pin A8. In addition, check the wiring between the EDC connector pin A32 and relay 86, EDC connector pin A8 and relay 85.	2.3 may get stored in memory since the fuel gets too warm.
			Heater fails to come on even with fuel temperature < 5°C. Filter may be clogged due to the fuel paraffining with harsh outdoor temperatures (< -15°C).	Check the continuity of the coil between the EDC connector pin A32 and relay A8. In addition, check the wiring between pins A32 of the control unit and relay 86, control unit A8 and relay 85.	Starting may be difficult with very cold temperatures. Engine starting may produce too much smoke.
2.9	On	Fan relay coil short-circuited or circuit open.	Increase in fuel consumption. Engine cooling fan always on even with engine cold. Or	Active diagnosis of the relay with the diagnosis instrument. Check coil continuity between EDC connector pin A39 and relay A8. In addition, check the wiring between the EDC connector pin A39 and relay 86, EDC connector pin A8 and relay 85.	In active diagnosis, besides the relay activating, you hear the fan's electromagnetic clutch cutting in and out.
			Engine overheating and accordingly possible power limitation. Engine cooling fan fails to work.	Check coil continuity between EDC connector pin A39 and relay A8. In addition, check the wiring between the EDC connector pin A39 and relay 86, EDC connector pin A8 and relay 85.	

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
3.1	Off	Injector no. 1 unbalanced.	Injector inefficient. There may be irregular rotation and smoke.	Engine test, cylinder efficiency test. Check the wiring and connections between the injector and the EDC connector pin A12 and A40. If the wiring is good, perform the compression test with the diagnosis instrument. If the compression in cylinder no. 1 is OK, replace the injector.	The control unit has to modify the signal to injector no. 1 (Cylinder Balancing) too far beyond the normal value.
3.2	Off	Injector no. 2 unbalanced.	Injector inefficient. There may be irregular rotation and smoke.	Engine test, cylinder efficiency test. Check the wiring and connections between the injector and the EDC connector pin A10 and A43. If the wiring is good, perform the compression test with the diagnosis instrument. If the compression in cylinder no. 2 is OK, replace the injector.	The control unit has to modify the signal to injector no. 2 (Cylinder Balancing) too far beyond the normal value.
3.3	Off	Injector no. 3 unbalanced.	Injector inefficient. There may be irregular rotation and smoke.	Engine test, cylinder efficiency test. Check the wiring and connections between the injector and the EDC connector pin A23 and A42. If the wiring is good, perform the compression test with the diagnosis instrument. If the compression in cylinder no. 3 is OK, replace the injector.	The control unit has to modify the signal to injector no. 3 (Cylinder Balancing) too far beyond the normal value.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
3.4	Off	Injector no. 4 unbalanced.	Injector inefficient. There may be irregular rotation and smoke.	Engine test, cylinder efficiency test. Check the wiring and connections between the injector and the EDC connector pin A24 and A41. If the wiring is good, perform the compression test with the diagnosis instrument. If the compression in cylinder no. 4 is OK, replace the injector.	The control unit has to modify the signal to injector no. 4 (Cylinder Balancing) too far beyond the normal value.
3.5	Off	Battery voltage too low (or recognized as such by the EDC control unit).	Fast idling up to 1250 rpm (depending on the voltage detected) with pedal released.	Check the efficiency of the batteries and recharging circuit, the efficiency of the earth points and that there are no deposits or oxidation on the connectors.	The engine cuts out or fails to start if the battery voltage < 6.5V.
3.6	Off	Pre-heating indicator lamp short-circuited or defective.	a) Pre-heating indicator light always on. b) Pre-heating indicator light always off.	Perform active diagnosis of the indicator light with the diagnosis instrument. Check wiring harness between EDC connector pin B21 and pre-heating warning light.	Even at low ambient temperatures, the driver fails to wait for pre-heating as no information is provided by the indicator light.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
3.7	Off	Glow plug relay short-circuited or circuit open.	Shorted to +Batt or circuit open: the glow plugs do not work, starting may be difficult and smokiness on starting. Shorted to earth: the glow plugs are always powered (short life).	Check the wiring of the EDC connector pin B42 to find the shorting to +Batt or to earth or the break in the circuit. Check the integrity of the pre-heating control unit. Check the 60A fuse connected between the battery positive and the pre-heating control unit connector pin 30. Check the power supply is correct on pin 86 of the pre-heating control unit and on the EDC connector pin B42. Check the earth connection of the pre-heating control unit pin 31.	
3.9	Off	Glow plugs short-circuited or circuit open.	Starting difficult with very rigid outdoor temperatures. Smokiness on starting.	Check the integrity of the single glow plugs. Check the glow plug power supply between the pre-heating control unit connector pin G1 – G2 – G3 – G4 and earth. If all OK, change the pre-heating control unit.	
5.1	Blinking	Electro-injector cylinder no. 1 shorted to +Batt. or shorted to earth or circuit open.	Drop in power made by the EDC control unit. The engine runs on 2 cylinders. Possibly 3.1. The engine runs on 3 cylinders.	Check the wiring and connections between the injector and the EDC connector pin A12 – A40. If the wiring is good, change the injector.	

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
5.2	Blinking	Electro-injector cylinder no. 2 shorted to +Batt. or	Drop in power made by the EDC control unit. The engine runs on 2 cylinders.	Check the wiring and connections between the injector and the EDC connector pin A10 – A43. If the wiring is good, change the injector.	
		shorted to earth or circuit open.	Possibly 3.2. The engine runs on 3 cylinders.		
5.3	Blinking	Electro-injector cylinder no. 3 shorted to +Batt. or	Drop in power made by the EDC control unit. The engine runs on 2 cylinders.	Check the wiring and connections between the injector and the EDC connector pin A23 – A42. If the wiring is good, change the injector.	
		shorted to earth or circuit open.	Possibly 3.3. The engine runs on 3 cylinders.		
5.4	Blinking	Electro-injector cylinder no. 4 shorted to +Batt. or	Drop in power made by the EDC control unit. The engine runs on 2 cylinders.	Check the wiring and connections between the injector and the EDC connector pin A24 – A41. If the wiring is good, change the injector.	
		shorted to earth or circuit open.	Possibly 3.4. The engine runs on 3 cylinders.		
5.7	Blinking	Power stage to supply the electro-injectors of cylinders 1 and 4 (in control unit) defective.	Possibly 3.1 – 3.4. The engine runs on 2 cylinders	Delete the fault memory and try again. If the error remains <u>and only after excluding the injector 1 or 4 defect</u>, call the Help Desk and follow their instructions to replace the control unit if necessary.	

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
5.8	Blinking	Power stage to supply the electro-injectors of cylinders 2 and 3 (in control unit) defective.	Possibly 3.2 – 3.3. The engine runs on 2 cylinders	Delete the fault memory and try again. If the error remains and only after excluding the injector 2 or 3 defect, call the Help Desk and follow their instructions to replace the control unit if necessary.	
6.1	Blinking	Crankshaft sensor: no signal or implausible signal.	The engine will not start cold, it could start warm with difficulty. With the engine running, power reduction and increased noise.	Check the integrity of the sensor (R = approx. 850 Ohm). If the sensor is sound, check the wiring between the sensor and EDC connector pin A29 – A37. Check the sensor is fastened properly.	If there is no crankshaft signal, the camshaft sensor speed signal is used instead. Power reduction (and noise reduction because the control unit cannot manage advance and duration of injection and bases itself on a recovery map. Pre-injection is not implemented).
6.2	Blinking	Camshaft sensor: no signal or implausible signal.	The engine will not start cold, it could start warm with difficulty. With the engine running, power reduction and increased noise. False injections during starting and smoke at the exhaust.	Check the integrity of the sensor (R = approx. 850 Ohm). If the sensor is sound, check the wiring between the sensor and EDC connector pin A4 – A31. Check the sensor is fastened properly.	If there is no camshaft signal, the flywheel sensor timing signal is used instead.
6.4	Off	The engine has over-revved (over 5500 rpm), probably driven, or crankshaft sensor signal not plausible (in this case, error 6.1 signalled).	If the over-revving occurred when driven, the driver can detect no reaction (other than the indicator light blinking).	Data saved to memory, check the duration and frequency of the over-revving. Delete the fault memory.	Make the driver aware about using the vehicle correctly.

BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
8.1	Blinking	Pressure in rail too great. The electric command fails to reach the pressure regulator.	The engine cuts out, loud noise before cutting out.	Check that the connector on the pressure regulator is connected. If it is connected, check the wiring between the regulator and the EDC connector pin A9 – A20.	After a few times, the pressure relief valve might remain open, in which case it has to be changed.
8.1	Blinking	Pressure in rail too great. Pressure regulator mechanically jammed open.	The engine cuts out, loud noise before cutting out.	Perform the high-pressure test with the diagnosis instrument. If the outcome is negative, replace the high-pressure pump – regulator assembly.	After a few times, the pressure relief valve might remain jammed open, in which case it has to be changed.
8.1	Blinking	Pressure in rail too low. Pressure regulator mechanically jammed shut.	The engine cuts out or fails to start.	Perform the high-pressure test with the diagnosis instrument. If the outcome is negative, replace the high-pressure pump – regulator assembly.	
8.1	Blinking	Pressure in rail too low. Shorting to +Batt. on the pressure regulator.	The engine cuts out or fails to start.	Check the wiring between the regulator and EDC connector pin A9 – A20.	
8.1	Blinking	Pressure in rail too low. High-pressure pump defective.	The engine cuts out or fails to start.	Perform the high-pressure test with the diagnosis instrument. If the outcome is negative, replace the high-pressure pump together with the regulator.	
8.1	Blinking	Injector mechanically jammed open.	The engine cuts out or fails to start.	Perform the cylinder efficiency test with the diagnosis instrument. If the outcome is negative, replace the defective injector.	
8.1	Blinking	Pressure in rail too low. Major fuel leak from the high-pressure circuit.	The engine cuts out or fails to start.	Check the high-pressure circuit and eliminate the leak (beware, there could be a leak inside the head between the high-pressure union and the injector).	

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
8.1	Blinking	Pressure in rail too low. Fuel supply problem in the low-pressure circuit.	The engine cuts out or fails to start.	Check the motor pump works properly, check for any clogging in the filter and pre-filter, crushed or leaking pipes, and check the fuel supply gear pump works properly.	
8.2	Blinking	Rail pressure sensor short-circuited or circuit open.	The engine cuts out.	Check the sensor is powered correctly. If the power supply is correct (approx. 5V) change the sensor. If it is greater than approx. 5V, check the wiring between the sensor and the EDC connector pin A33-A6.	
8.3	Blinking	Pressure regulator short-circuited or circuit open.	If shorted to +Batt., the pressure in the rail drops too much, the engine cuts out and fails to restart. Or	Check the wiring between the pressure regulator and the EDC connector pin A9 – A20.	8.1 – 8.2 may also be signalled.
			If shorted to earth or the circuit is open, the pressure in the rail rises above the maximum value and the engine cuts out.	Check the wiring between the pressure regulator and the EDC connector pin A9 – A20.	8.1 may also be signalled.

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
8.5	On	EGR monitoring: incorrect implementation of EGR percentage calculated by the control unit. (If present)	EGR is turned off. Emissions not conforming to legislation. Poor performance and smokiness at high engine speeds.	Check that the EGR pneumatic valve is not jammed shut or open (or intentionally tampered with). Check that the pipe between the solenoid valve and EGR pneumatic valve is not crushed, perforated or disconnected. Check the EGR solenoid valve works properly (active diagnosis with the diagnostic instrument). Using a multimeter, check the integrity of the solenoid valve. If the solenoid valve is sound, check the wiring between the solenoid valve and the EDC connector pin A25 – A8.	If there is a defect on the wiring of pin A8, the errors associated with all the devices connected to this pin will be saved to memory.
8.6	On	EGR solenoid valve short-circuited or circuit open. (If present)	EGR doesn't work or works constantly. Emissions not conforming to legislation. No reaction the driver can detect.	Check the EGR solenoid valve works properly (active diagnosis with the diagnostic instrument). Using a multimeter, check the integrity of the solenoid valve. If the solenoid valve is sound, check the wiring between the solenoid valve and the EDC connector pin A25 – A8.	If there is a defect on the wiring of the EDC connector pin A8, the errors associated with all the devices connected to this pin will be saved to memory.
8.7	On	Debimeter short-circuited or circuit open. (If present)	Power reduction and EGR function turned off. (If present)	Check the integrity of the debimeter and the wiring between the debimeter connector and the EDC connector pin A17 – A18 – A26 – A28.	
8.8	Off	EGR air temperature sensor short-circuited or circuit open. (If present)	No reaction the driver can perceive.	Read measurable parameters with the diagnosis instrument: in the event of this trouble, the ambient temperature read on the control unit will be fixed on 30°C. Check the wiring between the debimeter and EDC connector pin A5 – A18.	

BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
9.1	Blinking	Defect inside the control unit.	The engine cuts out or fails to start. In some cases, it might not cut out, but go onto the power reduction level.	Delete the fault memory. If the error remains, call the Help Desk and follow their instructions to replace the control unit if necessary.	This may occur when the power supply to the control unit is cut off without using the key. Perhaps no defect has been saved to memory, it depends on the state of defectiveness of the control unit.
9.2	On	EEPROM defect in control unit.	The data are not saved to memory when turning off the engine. The fault memory is lost, it is only possible to read the faults that are present but not the intermittent ones. Any idling speed set with the Cruise Control commands is not stored in memory. (If present)	Delete the fault memory. If the error remains, call the Help Desk and follow their instructions to replace the control unit if necessary.	
9.3	Blinking	Communication trouble with the immobilizer (if present); short-circuiting or circuit open on the CAN line.	The engine cuts out or fails to start.	Perform Immobilizer diagnosis and check the integrity of the CAN line.	
9.4	On	a) Main relay broken. b) Main relay short-circuited.	a) The control unit is not powered (the engine fails to start or cuts out). b) The control unit is constantly powered and the indicator light stays on even with the key turned OFF (the battery discharges).	Replace the main relay.	

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BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
9.5	Off	After Run broken off several times.	Fault memory and other working data are not corrected saved in EEPROM. EDC inhibits starting the engine after a certain number of unsuccessful After Runs.	Check the control unit power supply wiring for any intermittent false contacts. If the wiring is good, replace the main relay.	Investigate any incorrect use of the vehicle.
9.6	Blinking	Failure of the internal test procedure that takes place in the control unit every time the engine stops.	The engine fails to stop in the set time when the +15 key is turned onto OFF.	This could occur if the engine is turned off but it continues to be driven (vehicle moving with gear engaged). Check the wiring between the key +15 and the control unit connector pin B20. Delete the fault memory: if in normal conditions of turning off the engine the error signal persists, call the Help Desk to have the control unit replaced if necessary.	
9.7	Blinking	Internal defect of the control unit in the sensor power supply circuit.	Reduction in power (and noise because pre-injection is not implemented). Irregular engine operation due to sensors not being powered correctly.	Call the Help Desk and follow their instructions to replace the control unit if necessary.	Defects may be signalled for various sensors powered by the control unit.

BLINK CODE	EDC LAMP	POSSIBLE CAUSE	POSSIBLE TROUBLE	TESTS OR RECOMMENDED ACTION	NOTES
9.8	Blinking	Internal problem with the control unit software or an attempt to tamper with the data-set.	The engine fails to start or starts only occasionally.	Delete the fault memory: if the error remains, call the Help Desk and follow their instructions to reprogram or replace the control unit if necessary.	
9.9	Blinking	Internal problem with the control unit software (operating system).	Possible short breaks in injection because the control unit resets irregularly while the engine is running. Other defects may be signalled.	Delete the fault memory: if the error remains, call the Help Desk and follow their instructions to replace the control unit if necessary.	If this error is signalled together with other defects, resolve this problem first as it could be the cause of the others.

1st Section

DTC-FMI error codes with EDC central unit

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
0D	02	EGR - AIR MASS SUPPLY TOO HIGH (if present)	BELOW LOWER LIMIT	EGR off. Emissions not compliant with law. Derated performance and smoke at high engine rpm.	EGR monitoring: incorrect EGR percentage actuation calculated by ECU.	Check, if the EGR pneumatic valve is not locked in Open or Closed-Position 2) Check, that the solenoid valve and the EGR pneumatic valve is not squashed or holed or detached 3) Check the EGR solenoid valve-functionality 4) Check the solenoid valve-integrity by means of a multimeter 5) Check the wiring harness between the solenoid valve and the EDC connector.				
11	01	ENGINE 1 - BOOST PRESSURE SENSOR	EXCEEDED UPPER LIMIT	Positive power reduction and smoke in exhaust.		Check wiring and connections. Possibly replace sensor. Check in "measurable parameter" environment that atmospheric pressure sensor and turbo charger air pressure sensor values are similar when engine is off.				Possible smoke in exhaust during acceleration. Replace if required.
11	02	ENGINE 1 - BOOST PRESSURE SENSOR	BELOW LOWER LIMIT	Positive power reduction and smoke in exhaust.		Check wiring and connections. Replace sensor if required.				Possible smoke in exhaust during acceleration. Replace if required.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
11	08	ENGINE 1 - BOOST PRESSURE SENSOR	SIGNAL NOT PLAUSIBLE	Positive power reduction and smoke in exhaust.	Faulty sensor.	Check wiring and connections. Replace sensor if required.				
12	01	ENGINE 2 - BATTERY VOLTAGE	EXCEEDED UPPER LIMIT	Problematic cranking.	Flat battery, interrupted wiring.	Check battery state with diagnostic tool (measurable parameters). Check wiring and connections.				Replace alternator, regulator or battery.
12	02	ENGINE 2 - BATTERY VOLTAGE	BELOW LOWER LIMIT	Engine does not start. Possible power reduction.	Faulty battery, faulty alternator, faulty ECU.	Check with diagnostic tool.				Replace battery, alternator or ECU if required.
13	08	VEHICLE - BRAKE PEDAL SIGNAL ERROR	SIGNAL NOT PLAUSIBLE	Brake signal plausibility, possibly no brake lights, Cruise Control / PTO not working.	The two switch states are different.	Check wiring and connections. Replace sensor if required.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
14	01	ENGINE 1 - COOLANT TEMPERATURE SENSOR	EXCEEDED UPPER LIMIT	Problematic cold cranking. Possible power reduction.	Faulty sensor, interrupted wiring.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	
14	02	ENGINE 1 - COOLANT TEMPERATURE SENSOR	BELOW LOWER LIMIT	Problematic cold cranking. Possible power reduction.	Faulty sensor, interrupted wiring.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
14	08	ENGINE 1 - COOLANT TEMPERATURE SENSOR	SIGNAL NOT PLAUSIBLE	Problematic cold cranking. Possible power reduction.	Faulty sensor, interrupted wiring.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	
15	01	ENGINE 1 - COOLANT TEMPERATURE SENSOR (TEST)	EXCEEDED UPPER LIMIT		Faulty coolant temperature sensor.	Replace sensor.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1E	08	VEHICLE - CLUTCH SIGNAL SUSPECT	SIGNAL NOT PLAUSIBLE	Clutch switch: signal either not plausible or not present. Cruise Control / PTO not working or engine revs up to maximum speed when clutch pedal is pressed and Cruise control / PTO is on.	Gear shift detected without pressing brake pedal.	Check wiring and connections. Replace sensor if required.				The anomaly caused by incomplete clutch operation if everything is OK.
20	01	EGR - EGR POWER ST. SHORT TO BATT. (if present)	EXCEEDED UPPER LIMIT		EGR solenoid valve short-circuit to battery.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.
21	02	EGR - SHORT CIRCUIT TO GROUND ON EGR VALVE (if present)	BELOW LOWER LIMIT		Solenoid valve short-circuit to ground.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.
22	04	EGR - OPEN CIRCUIT ON EGR VALVE (if present)	NO SIGNAL		EGR solenoid valve short-circuit or open circuit.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
22	08	EGR - OPEN CIRCUIT ON EGR VALVE (if present)	SIGNAL NOT PLAUSIBLE		EGR solenoid valve short-circuit or open circuit.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.
24	01	ENGINE SPEED - CAMSHAFT SENSOR	EXCEEDED UPPER LIMIT	Possible problematic cold cranking.	No signal, open circuit.	Check wiring and connections.				Flywheel sensor timing signal adopted if camshaft signal is not correct.
24	02	ENGINE SPEED - CAMSHAFT SENSOR	BELOW LOWER LIMIT	Possible problematic cold cranking.	No signal, open circuit, faulty sensor.	Check correct assembly of sensor and phonic wheel, check engine timing.				Flywheel sensor timing signal adopted if camshaft signal is not correct.
25	01	ENGINE SPEED - CRANKSHAFT SENSOR	EXCEEDED UPPER LIMIT	Problematic cold cranking, power reduction (possible noise due to missed pre-injection).	Faulty sensor.	Check wiring and connections.				Camshaft sensor speed adopted if signal is not present.
25	02	ENGINE SPEED - CRANKSHAFT SENSOR	BELOW LOWER LIMIT	Problematic cold cranking, power reduction (possible noise due to missed pre-injection).	Faulty sensor.	Check wiring and connections.				Camshaft sensor speed adopted if signal is not present.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
26	01	ENGINE SPEED - FAULT BETWEEN FLYWHEEL SENSOR AND CAMSHAFT	EXCEEDED UPPER LIMIT	Possible power reduction.	Incorrect camshaft phonic wheel assembly.	Check wiring, connections and sensor, check that phonic wheel is fitted correctly.				Longer cranking time.
28	01	ENGINE 1 - FUEL TEMPERATURE SENSOR	EXCEEDED UPPER LIMIT	Possible power reduction.	Short-circuit to positive, excessively low temperature is detected.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (Ohm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A52 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A51 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
28	02	ENGINE 1 - FUEL TEMPERATURE SENSOR	BELOW LOWER LIMIT	Possible power reduction.	Short-circuit to ground, excessively high temperature is detected.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (Ohm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A52 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A51 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	
29	01	ENGINE 1 - FAN RELAY	EXCEEDED UPPER LIMIT	Fan relay not working.	Fan relay short-circuit to positive.	Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
29	02	ENGINE 1 - FAN RELAY	BELOW LOWER LIMIT	Fan relay not working.	Fan relay short-circuit to ground.	Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
29	04	ENGINE 1 - FAN RELAY	NO SIGNAL	Fan relay not working.		Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
29	08	ENGINE 1 - FAN RELAY	SIGNAL NOT PLAUSIBLE	Fan relay not working.		Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
2A	01	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	EXCEEDED UPPER LIMIT	Fuel filter pre-heater relay not working.	Filter heater relay short-circuit to positive - Heater always on also at fuel temperature > 5° C.	Check wiring and connections. Replace relay if required.				Battery goes flat.
2A	02	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	BELOW LOWER LIMIT	Fuel filter pre-heater relay not working.	Filter heater relay short-circuit to ground.	Check wiring and connections. Replace relay if required.				Battery goes flat.
2A	04	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	NO SIGNAL	Fuel filter pre-heater relay not working.		Check wiring and connections. Replace relay if required.				Battery goes flat.
2A	08	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	SIGNAL NOT PLAUSIBLE	Fuel filter pre-heater relay not working.		Check wiring and connections. Replace relay if required.				Battery goes flat.
2F	01	ENGINE 2 - GLOW PLUGS RELAY	EXCEEDED UPPER LIMIT	Possible problematic cold cranking.	Short-circuit to positive, glow plugs always on also with ECU off, possible battery deployment.	Check wiring and connections. Replace relay if required.				
2F	02	ENGINE 2 - GLOW PLUGS RELAY	BELOW LOWER LIMIT		Short-circuit to ground, glow plugs always on.	Check wiring and connections. Replace relay if required.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
2F	04	ENGINE 2 - GLOW PLUGS RELAY	NO SIGNAL	Possible problematic cold cranking.	Faulty wiring.	Check wiring and connections. Replace relay if required.				Faulty diagnostic light.
2F	08	ENGINE 2 - GLOW PLUGS RELAY	SIGNAL NOT PLAUSIBLE	Possible problematic cold cranking.	Faulty relay, wiring interrupted.	Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
30	01	ENGINE 2 - GLOW PLUG W/LIGHT	EXCEEDED UPPER LIMIT	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.	Short-circuit to positive.	Check wiring and connections. Replace sensor if required.				The driver does not wait preheating even when the room temperatures are low, because no warning light signal is enabled. Preheating works, but with cold start-up no indication is available that tells you when to start the motor because the light is always turned on.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
30	02	ENGINE 2 - GLOW PLUG W/LIGHT	BELOW LOWER LIMIT	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.	Short-circuit to ground.	Check wiring and connections. Replace sensor if required.				The driver does not wait preheating even when the room temperatures are low, because no warning light signal is enabled. Preheating works, but with cold start-up no indication is available that tells you when to start the motor because the light is always turned on.
30	04	ENGINE 2 - GLOW PLUG W/LIGHT	NO SIGNAL	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.		Check wiring and connections. Replace sensor if required.				Warning light off during pre-heating. Replace bulb if required.
30	08	ENGINE 2 - GLOW PLUG W/LIGHT	SIGNAL NOT PLAUSIBLE	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.		Check wiring and connections. Replace sensor if required.				Warning light off during pre-heating. Replace bulb if required.
31	01	ENGINE 2 - GLOW PLUGS	EXCEEDED UPPER LIMIT	Possible problematic cold cranking.	Short-circuit to positive.	Check wiring and connections. Check electrical system between relay and glow plugs.				Relay unit always on also with ECU off, possible battery deployment.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
32	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
33	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
33	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
33	04	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	NO SIGNAL	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
33	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
34	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
35	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
36	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
37	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
38	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
39	01	ENGINE 1 - AIR TEMPERATURE SENSOR	EXCEEDED UPPER LIMIT	Problematic cranking, smoke, problematic acceleration.		Check wiring and connections. Replace sensor if required.	Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2	Connector Not connected; Key +15 OFF;	Typical Value: 2,5 KOhm;	Air temperature sensor and built-in pressure sensor. The sensor is fitted on flow meter in engines with EGR.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
39	02	ENGINE 1 - AIR TEMPERATURE SENSOR	BELOW LOWER LIMIT	Problematic cranking, smoke, problematic acceleration.	Short-circuit to ground, excessively high temperature is detected.	Check wiring and connections. Replace sensor if required.	Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2	Connector Not connected; Key +15 OFF;	Typical Value: 2,5 KOhm;	Air temperature sensor and built-in pressure sensor. The sensor is fitted on flow meter in engines with EGR.
3A	02	ELECTRONIC CONTROL UNIT - IMMOBILISER (if present)	BELOW LOWER LIMIT	The engine fails to start	Communication with Immobilizer ECU problems on CAN Line.	Check integrity of CAN Line, run Immobilizer ECU diagnostics and wait for indications provided.	Measure type: Resistance (Ohm) Measure point 1: Diagnostic socket. Pin: 21 Measure point 2: Diagnostic socket. Pin: 22	Connector Connected; Key +15 OFF;	Typical Value: 60 Ohm Ohm;	
3C	01	INJECTOR - BENCH 1	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3C	02	INJECTOR - BENCH 1	BELOW LOWER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to ground.	Check wiring and connections.				Only two cylinders running.
3C	08	INJECTOR - BENCH 1	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector electrical system failure.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3D	04	INJECTOR - BENCH 1	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring disconnected.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3E	01	INJECTOR - BENCH 2	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
3E	02	INJECTOR - BENCH 2	BELOW LOWER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to ground.	Check wiring and connections.				Only two cylinders running.
3E	08	INJECTOR - BENCH 2	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector electrical system failure.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3F	04	INJECTOR - BENCH 2	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring disconnected.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
40	01	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	EXCEEDED UPPER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
40	02	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	BELOW LOWER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
40	04	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	NO SIGNAL	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
40	08	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	SIGNAL NOT PLAUSIBLE	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
41	01	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	EXCEEDED UPPER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
41	02	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	BELOW LOWER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
41	04	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	NO SIGNAL	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
41	08	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	SIGNAL NOT PLAUSIBLE	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
42	01	INJECTOR - INJECTOR 1	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.				Only three cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
42	01	INJECTOR - INJECTOR 1	EXCEEDED UPPER LIMIT				1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A47 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A16 Measure point 2: Injector Pin: 1	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0.1 Ohm; 2- Min. value: 0.5 Ohm; Max. value: 0.9 Ohm; Typical Value: 0.7 Ohm; 3- Typical Value: 0,1 Ohm;	
42	04	INJECTOR - INJECTOR 1	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A47 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A16 Measure point 2: Injector Pin: 1	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0.1 Ohm; 2- Min. value: 0.5 Ohm; Max. value: 0.9 Ohm; Typical Value: 0.7 Ohm; 3- Typical Value: 0,1 Ohm;	Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
42	08	INJECTOR - INJECTOR 1	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A47 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A16 Measure point 2: Injector Pin: 1	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0.1 Ohm; 2- Min. value: 0.5 Ohm; Max. value: 0.9 Ohm; Typical Value: 0.7 Ohm; 3- Typical Value: 0,1 Ohm;	Only three cylinders running.
43	04	INJECTOR - INJECTOR 1	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.				Only three cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
44	01	INJECTOR - INJECTOR 2	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A17 Measure point 2: Injector Pin: 1 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A13 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: O,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
44	04	INJECTOR - INJECTOR 2	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A17 Measure point 2: Injector Pin: 1 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A13 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: O,9 Ohm; Typical Value: 0,7 Ohm;	Only two cylinders running.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
44	08	INJECTOR - INJECTOR 2	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A17 Measure point 2: Injector Pin: 1 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A13 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: O,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
45	04	INJECTOR - INJECTOR 2	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
46	01	INJECTOR - INJECTOR 3	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
46	04	INJECTOR - INJECTOR 3	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
46	08	INJECTOR - INJECTOR 3	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
47	04	INJECTOR - INJECTOR 3	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A31 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A1 Measure point 2: Injector Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: 0,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
48	01	INJECTOR - INJECTOR 4	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
48	04	INJECTOR - INJECTOR 4	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
48	08	INJECTOR - INJECTOR 4	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
49	04	INJECTOR - INJECTOR 4	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A46 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A1 Measure point 2: Injector Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: 0,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
4E	08	VEHICLE - CRUISE CONTROL SWITCH UNIT (if present)	SIGNAL NOT PLAUSIBLE	Cruise control / PTO not working.	Press SET+ / SET- and RESUME/ OFF at the same time.	Check correct operation of the switch by reading state parameters.				Replace wiring and connections if state does not change when Cruise Control buttons are pressed.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
50	01	ELECTRONIC CONTROL UNIT - MAIN RELAY DEFECT	EXCEEDED UPPER LIMIT	Engine does not start, ECU not powered or ECU always powered and EDC off also at key-on.	Main relay interrupted or short-circuit.	Check wiring and connections. Replace relay if required.				
50	02	ELECTRONIC CONTROL UNIT - MAIN RELAY DEFECT	BELOW LOWER LIMIT	Engine does not start, ECU not powered or ECU always powered and EDC off also at key-on.	Main relay interrupted or short-circuit.	Check wiring and connections. Replace relay if required.				
51	01	VEHICLE - MULTIPOSITION SELECTOR / PTO (if present)	EXCEEDED UPPER LIMIT	Incorrect PTO operation.	Voltage exceeding max. threshold, short-circuit to positive.	Check wiring and connections. Replace sensor if required.				
51	02	VEHICLE - MULTIPOSITION SELECTOR / PTO (if present)	BELOW LOWER LIMIT	Incorrect PTO operation.	Voltage under min. threshold, short-circuit to ground.	Check wiring and connections. Replace sensor if required.				
51	08	VEHICLE - MULTIPOSITION SELECTOR / PTO (if present)	SIGNAL NOT PLAUSIBLE	Incorrect PTO operation.	Faulty device.	Check wiring and connections. Replace sensor if required.				
52	04	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR	NO SIGNAL	Engine off.	Faulty MPROP.	Check wiring and connections.	Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A49 Measure point 2: ECU Pin: A19	Connector Not connected; Key +15 OFF;	Min. value: 3.2 Ohm; Max. value: 3.6 Ohm; Typical Value: 3.4 Ohm;	High noise.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
52	08	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR	SIGNAL NOT PLAUSIBLE			Check wiring and connections. Replace ECU if required.	Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A49 Measure point 2: ECU Pin: A19	Connector Not connected; Key +15 OFF;	Min. value: 3.2 Ohm; Max. value: 3.6 Ohm; Typical Value: 3.4 Ohm;	
53	01	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR (SHORT CIRCUIT TO POSITIVE)	EXCEEDED UPPER LIMIT		Short-circuit to battery, faulty MPROP.	Check wiring and connections. Replace MPROP if required.				
54	01	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR (SHORT CIRCUIT TO NEGATIVE)	EXCEEDED UPPER LIMIT		Short-circuit to ground. Faulty MPROP.	Check wiring and connections. Replace MPROP if required.				
56	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagneti c interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
5A	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Wrong ECU programming. Probable electromagneti c interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
5A	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
5B	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
5E	01	ENGINE 1 - FUEL PUMP RELAY	EXCEEDED UPPER LIMIT	Fuel pump on always when engine is off.	Faulty relay, short-circuit to positive in wiring.	Turn key-on: pump must run for approximately 10 seconds (it should hum). Check pump relay if pump remains on. Check wiring if all checks are OK.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
5E	02	ENGINE 1 - FUEL PUMP RELAY	BELOW LOWER LIMIT	Fuel pump not working.	Faulty relay, short-circuit to ground in wiring.	Turn key-on: pump must run for approximately 10 seconds (it should hum). Check the pump relay, protection fuse and wiring if this does not occur.				
5E	04	ENGINE 1 - FUEL PUMP RELAY	NO SIGNAL	Fuel pump not working.	Faulty relay, wiring interrupted.	Check wiring and connections. Replace relay if required.				
5E	08	ENGINE 1 - FUEL PUMP RELAY	SIGNAL NOT PLAUSIBLE	Fuel pump not working.	Faulty relay, wiring interrupted.	Check wiring and connections. Replace relay if required.				
5F	01	FUEL PRESSURE - RAIL PRESSURE SENSOR OR SIGNAL ERROR	EXCEEDED UPPER LIMIT		Short-circuit to positive. Faulty sensor. Rail pressure not regular.	Check wiring and connections. Replace sensor if required.				Check DTC 103 error.
5F	02	FUEL PRESSURE - RAIL PRESSURE SENSOR OR SIGNAL ERROR	BELOW LOWER LIMIT		Short-circuit to ground, faulty sensor.	Check wiring and connections. Replace sensor if required.				
60	01	FUEL PRESSURE - RAIL PRESSURE SENSOR OFFSET	EXCEEDED UPPER LIMIT		Faulty rail pressure sensor.	Replace sensor.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
60	02	FUEL PRESSURE - RAIL PRESSURE SENSOR OFFSET	BELOW LOWER LIMIT		Faulty rail pressure sensor.	Replace sensor.				
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		High pressure circuit fuel leakage.	Check fuel feed system.				Fuel management and pressure failure in rail.
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		Injector jammed in fuel passage open position.	Check hydraulic and mechanical efficiency of injectors.				Fuel management and pressure failure in rail.
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		MPROP adjuster open movement jammed.	Check efficiency of MPROP adjuster.				Fuel management and pressure failure in rail.
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		Faulty high pressure pump.	Check efficiency of high pressure pump.				Fuel management and pressure failure in rail.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
63	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (NEGATIVE DEVIATION)	EXCEEDED UPPER LIMIT		MPROP adjuster open movement jammed.	Check efficiency of MPROP adjuster.				Fuel management and pressure failure in rail.
64	01	FUEL PRESSURE - RAIL PRESSURE ERROR: TOO LOW	EXCEEDED UPPER LIMIT		High pressure circuit fuel leakage.	Check high pressure system. Replace high pressure pump if required.				Fuel management and pressure failure in rail.
65	01	FUEL PRESSURE - RAIL PRESSURE ERROR: TOO HIGH	EXCEEDED UPPER LIMIT		MPROP regulator jammed.	Check MPROP regulator, replace if required.				
66	01	FUEL PRESSURE - ERROR ON THE RAIL PRESSURE (EXCESSIVE DUTY CYCLE)	EXCEEDED UPPER LIMIT	Negative vehicle reaction with smoke in exhaust during acceleration.	High pressure circuit fuel leakage.	Check fuel feed system, replace high pressure pump if required. Faulty fuel feed system (fuel pump and filter jammed).				
67	01	FUEL PRESSURE - ERROR ON THE RAIL PRESSURE (EXCESSIVE)	EXCEEDED UPPER LIMIT	Engine off.	MPROP regulator jammed.	Check MPROP regulator, replace if required.				Replace pressure relief valve.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
68	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT			Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
68	04	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	NO SIGNAL		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
68	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
69	01	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	EXCEEDED UPPER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
69	02	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	BELOW LOWER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6A	01	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	EXCEEDED UPPER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
6A	02	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	BELOW LOWER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6B	01	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	EXCEEDED UPPER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6B	02	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	BELOW LOWER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6C	01	VEHICLE - EDC LAMP	EXCEEDED UPPER LIMIT	Warning light not working.	Short-circuit to positive.	Check correct operation of warning light using "Active diagnostic" procedure.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
6C	02	VEHICLE - EDC LAMP	BELOW LOWER LIMIT	Warning light not working.	Short-circuit to ground.	Check correct operation of warning light using "Active diagnostic" procedure.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.
6C	04	VEHICLE - EDC LAMP	NO SIGNAL	Warning light not working.	Open circuit, bulb disconnected.	Check correct operation of warning light using "Active diagnostic" procedure.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.
6C	08	VEHICLE - EDC LAMP	SIGNAL NOT PLAUSIBLE	Warning light not working.	Wiring problems.	Check wiring and connections. Replace sensor if required.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.
6D	08	ENGINE 2 - INTERNAL ECU FAULT (PLAUSIBILTY ERROR +15)	SIGNAL NOT PLAUSIBLE			Check wiring and connections.				Key 15 off during initialisation.
6E	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
75	01	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	EXCEEDED UPPER LIMIT	Speed of 170 km/h exceeded.		Check correct calibration of speedometer.				Encourage driver to use the vehicle correctly.
75	04	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	NO SIGNAL		Interrupted wiring between vehicle speed sensor and instrument panel.	Check wiring and connections between vehicle speed sensor and instrument panel.				Intervention required if instrument panel indicates vehicle speed.
75	04	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	NO SIGNAL		Wiring interrupted between instrument panel and EDC ECU.	Check wiring and connections between instrument panel and EDC ECU.				
75	04	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	NO SIGNAL		Vehicle speed sensor disconnected or failed.	Check correct assembly and efficiency of vehicle speed sensor.				
75	08	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	SIGNAL NOT PLAUSIBLE		Vehicle speed sensor disconnected or failed.	Check correct assembly and efficiency of vehicle speed sensor.				
75	08	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	SIGNAL NOT PLAUSIBLE	Vehicle speed on instrument panel does not increase sensibly.	Wrong speedometer setting.	Check correct calibration of speedometer.				
77	01	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	EXCEEDED UPPER LIMIT	Wrong vehicle speed indication.	Wrong speedometer setting.	Check correct calibration of speedometer.				
77	02	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	BELOW LOWER LIMIT	Wrong vehicle speed indication.	Wrong speedometer setting.	Check correct calibration of speedometer.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
77	08	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	SIGNAL NOT PLAUSIBLE	Wrong vehicle speed indication.	Wrong speedometer setting.	Check correct calibration of speedometer.				
79	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

2nd Section
SYMPTOMS

The second section describes possible trouble that **is not identifiable by the control unit and is**

SPECIFIC TO THE COMMON RAIL SYSTEM AND THE NEW HW ENGINE

HYDRAULIC

ELECTRIC

MECHANICAL

other than conventional defects

(the aim is to guide the diagnostic approach to a new system, not to restate basic concepts that are considered to have already been acquired by the repairer).

The possible trouble already identified by the control unit, described in the 1st Section, is not repeated here (e.g., the engine cuts out as a result of defect 8.1).

If there are errors stored in the control unit memory, refer to the 1st troubleshooting section.

- ❑ The engine cuts out or fails to start.
- ❑ The engine fails to start (considerable exhaust smoke).
- ❑ The engine starts with difficulty.
- ❑ The engine fails to reach its top performance.

SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine cuts out or fails to start.	The EDC indicator light fails to come on. The starter motor turns but the engine fails to start.	EDC control unit not powered: fuse blown.	Check central unit EDC protection fuse. If the fuse has blown, find and eliminate the cause of the overload before replacing it.	
The engine cuts out or fails to start.	The EDC indicator light fails to come on. The starter motor turns but the engine fails to start.	EDC control unit not powered: the main relay is not powered.	Check the wiring upstream from the main relay to find any break in the circuit.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Air intake in the supply circuit between the tank and motor pump.	Check the integrity of the pipe and check that the quick couplings on the CILC (fuel level indicator assembly) and on the motor pump inlet are fitted properly. Replace any non-conforming parts.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Pre-filter clogged.	Inspect and replace the pre-filter if any debris is found inside.	The pre-filter is transparent and any debris is easy to see.
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Low-pressure pipe between motor pump and high-pressure pump inlet choked or with large leak.	Inspect the pipe and replace the relevant section.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Fuel filter greatly clogged (within certain limits it only involves difficult starting).	Replace the filter.	If the filter clogging indicator system has not worked, check the relevant electric circuit and restore its operation.

SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Rail pressure relief valve jammed open or lost its setting (continually discharges towards the tank).	If fuel has come out of the valve exhaust pipe while driving with the starter motor, change the valve.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Mechanical defect in the gear pump, pressure regulator and the pumping elements of the high-pressure pump.	After checking there is fuel in the tank and excluding every other possibility (see 1st Troubleshooting Section), replace the high-pressure pump together with the pressure regulator.	
The engine cuts out or fails to start.	The starter motor turns but the engine fails to start. The rail pressure during starting regularly rises above 200 bar.	EGR pneumatic valve jammed open and air throttle valve jammed shut. (If present)	Check and replace the defective components.	
The engine starts with difficulty.	The EDC control unit is powered, the starter motor turns but the engine starts only after insisting a long time. Very slow increase in rail pressure.	The fuel motor pump is not powered (no buzzing is heard with the key ON for 9 sec.).	Check that no electric cable has disconnected from the motor pump. Check the wiring between the control relay and the motor pump to identify any break in the circuit.	After starting, with a load request the engine goes into recovery (if due to insufficient fuel reaching the high-pressure pump error 8.1 is detected, see 1st Section).
The engine starts with difficulty.	The rail pressure during starting regularly rises above 200 bar.	Injector mechanically jammed shut.	Perform the Engine Test (cylinder efficiency) to identify the defective injector and replace it.	Depending on the extent of the jamming, the control unit might detect a lack of balance between the cylinders (See error 3.1 – 3.2 – 3.3 – 3.4, 1st Section).
The engine starts with difficulty.	The rail pressure during starting regularly rises above 200 bar.	EGR pneumatic valve jammed open or air throttle valve mechanically jammed shut. (If present)	Check which component is defective and replace it.	

SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine starts with difficulty.	The rail pressure during starting does not reach 200 bar immediately.	Air intake in the supply circuit between the tank and motor pump.	Check the integrity of the pipe and check that the quick couplings on the CILC (fuel level indicator assembly) and on the motor pump inlet are fitted properly. Replace any non-conforming parts.	
The engine starts with difficulty.	The rail pressure during starting does not reach 200 bar immediately.	The motor pump is not powered (no buzzing is heard with the key ON for 9 sec.).	Check the wiring between the control relay and the motor pump.	
The engine starts with difficulty.	The rail pressure during cranking does not reach 200 bar immediately.	Low-pressure pipe choked or broken or leaking.	Inspect the pipe and replace the relevant section.	
The engine starts with difficulty.	The rail pressure during cranking does not reach 200 bar immediately.	Fuel filter very clogged.	Replace the filter. If the filter clogging indicator system has not worked, check the relevant circuit and restore its operation.	
The engine fails to reach top performance	(with no derating implemented by the control unit)	Throttle pedal potentiometer does not go to the end of its travel.	Read parameters, check the signal reaches 100%. If it does not, check the physical integrity of the potentiometer and replace it if necessary.	If there are errors saved in the control unit memory, refer to the 1st Troubleshooting Section.
The engine fails to reach top performance	(with no derating implemented by the control unit)	EGR pneumatic valve jammed open or throttle valve jammed shut. (If present)	Check which is the defective component and replace it.	
The engine fails to reach top performance	(with no derating implemented by the control unit)	Injector jammed shut.	Find the defective injector (cylinder efficiency test with the diagnostic instrument) and replace it.	

SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine fails to reach top performance	(with no derating implemented by the control unit)	Fuel filter greatly clogged.	Change the filter. If the filter clogging indicator system has not worked, check the relevant circuit and restore its operation.	
The engine fails to reach top performance	(with no derating implemented by the control unit)	The motor pump is not powered (no buzzing is heard with the key ON for 9 sec.).	Check the wiring between the control relay and the motor pump.	

PART FOUR - MAINTENANCE PLANNING

Maintenance

MAINTENANCE

The covered distances indicated in this schedule are typical of engines used in vehicles.

Recovery

To ensure optimised working conditions, in the following pages we are providing instructions for the overhaul control interventions, checks and setting operations that must be performed on the engine at due planned dates.

The frequency of the maintenance operations is just an indication since the use of the engine is the main characteristic to determine and evaluate replacements and checks.

It is not only allowed but recommended that the staff in charge of the maintenance should also carry out the necessary maintenance and controlling operations even if not being included in the ones listed here below but that may be suggested by common sense and by the specific conditions in which the engine is run.

Checks not included in maintenance planning-daily checks

It is a good habit to execute, before engine start, a series of simple checks that might represent a valid warranty to avoid inconveniences, even serious, during engine running. Such checks are usually up to the operators and to the vehicle's drivers.

- Level controls and checks of any eventual leakage from the fuel, cooling and lubricating circuits.

- Notify the maintenance if any inconvenience is detected of if any filling is necessary.

After engine start and while engine is running, proceed with the following checks and controls:

- check presence of any eventual leakage from the fuel, cooling and lubricating circuits.

- Verify absence of noise or unusual rattle during engine working.

- Verify, using the vehicle devices, the prescribed pressure temperature and other parameters.

- Visual check of fumes (colour of exhaust emissions)

- Visual check of cooling liquid level, in the expansion tank.

Inspection and/or maintenance interventions

	Type of intervention	Regular intervals
LUBRICATION, CHANGING OIL, FILTERS AND CHECKING FLUIDS		
1	Changing engine oil	40.000
1	Changing engine oil filter	40.000
2	Changing fuel filter *	40.000
3	Visually checking fuel pre-filter clogging (if present)	40.000
CHECKS IN THE ENGINE BAY		
•	Checking state of auxiliary drive belts	40.000
•	Changing auxiliary drive belts (1)	120.000
DIAGNOSTICS		
•	Engine EDC system check-up via diagnosis tool	120.000

(1) *Replace every four years. Replace every 60.000 km under harsh conditions of use (dust and/or heat).*

(*) *If the "clogged filter" warning lamp lights up on the instrument panel, the filter must be replaced before the programmed replacement interval*

The frequency of the maintenance operations is just an indication since the use of the F1A engine is the main characteristic to determine and evaluate replacements and checks.
The maintenance operations are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Extra plan operations (to be carried out possibly in combination with maintenance service)

EVERY 80,000 km or 1600 hours (EGR engine only)

- ❑ Air flow rate meter (flowmeter) check with diagnosis apparatus
- ❑ Air flow meter replacement (1)

EVERY 240,000 km or, anyhow, every 5 years (or 4,800 hours)

- ❑ Changing the timing system driving belt (2).
- ❑ Changing the automatic tensioner of the timing system driving belt.
- ❑ Changing the automatic tensioner of the belt driving the alternator and hydraulic pump
- ❑ Changing the pre-heating glow plugs.

EACH YEAR - especially in early springtime

- ❑ In the case of low mileage, change the filters once a year, early each spring.

EACH YEAR - before the winter season

- ❑ Check coolant density.

EVERY THREE YEARS - even if there is no indication of the air filter clogging

- ❑ Change cartridge and clean air filter container (3).
- ❑ Change engine coolant.

(1) *Replacement is mandatory also if the flow meter does not appear faulty following the test.*

(2) *The timing belt must be replaced in any case every 5 years.*

(3) *Early air cleaner obstruction is generally due to particular environmental conditions. For this reason it may need to be replaced when indicated by the sensor regardless of the replacement interval also if not specifically stated.*

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SECTION 4

Features and general overhaul

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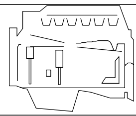
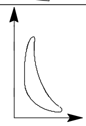
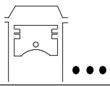
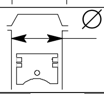
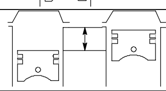
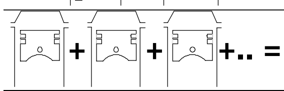
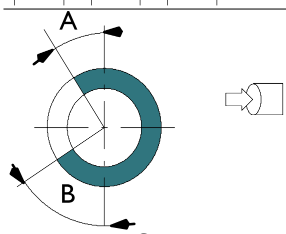
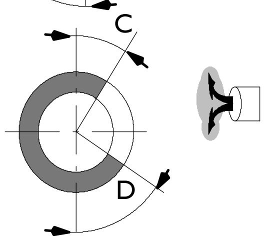
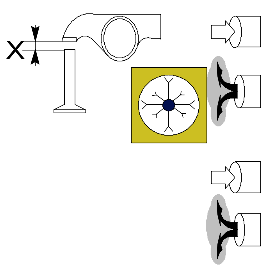
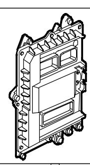
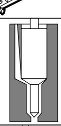
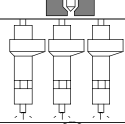
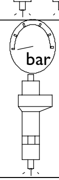
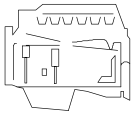
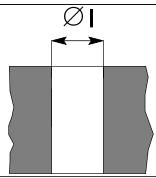
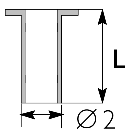
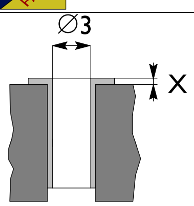
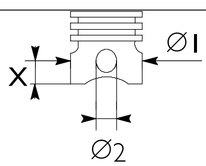
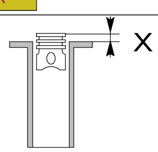
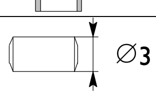
GENERAL SPECIFICATIONS

	Type		F1AE0481A*....	F1AE0481B*....
	Cycle		Diesel 4 strokes	
	Supply		Turbocharged with intercooler	
	Injection		Direct	
	Number of cylinders		4 in line	
	Bore	mm	88	
	Stroke	mm	94	
	Total displacement	cm^3	2300	
	TIMING SYSTEM			
	Start before T.D.C.	A	14°	
	end after B.D.C.	B	27°	
	Start before T.D.C.	D	54°	
	end after B.D.C.	C	10°	
	For timing check			
	X	mm	-	
		mm	-	
	Operation			
	X	mm	-	
		mm	-	
	FUEL FEED			
	Injection Type:	Bosch	high pressure common rail EDC16	
	Nozzle type		Injectors BOSCH	
	Injection sequence		1 - 3 - 4 - 2	
	Injection pressure	bar	1600	

ASSEMBLY DATA – CLEARANCES

	Type		**F1AE0481A*....**	**F1AE0481B*....**
CYLINDER ASSEMBLY AND CRANK MEMBERS				
	Cylinder liners:	∅ 1	88.002 ÷ 88.022	
	Cylinder liners: outside diameter length	 ∅ L	- - -	
	Cylinder liners – crankcase seats (interference)		-	
IVECO PARTS >	Outside diameter	∅ 2	-	
	Cylinder liners: (protrusion from bottom of crankcase) inside diameter	 ∅ 3	- -	
	Pistons: supplied as spares type measurement outside diameter seat for pin	 X ∅ 1 ∅ 2	 FEDERAL MOGUL 46 87.801 ÷ 87.815 31.003 ÷ 31.009	 MAHLE MONDIAL 45.5 87.832 ÷ 87.846
	Piston – cylinder liners		0.187 ÷ 0.221	0.156 ÷ 0.190
IVECO PARTS <	Piston diameter	∅ 1	0.4	
	Piston protrusion from crankcase	X	0.3 ÷ 0.6	
	Piston gudgeon pin	∅ 3	30.990 ÷ 30.996	
	Piston gudgeon pin – pin seat		0.07 ÷ 0.019	

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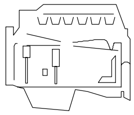
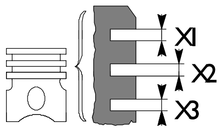
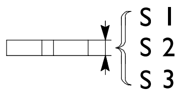
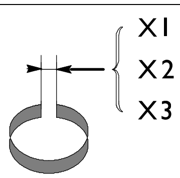
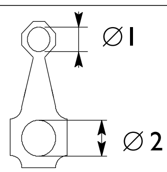
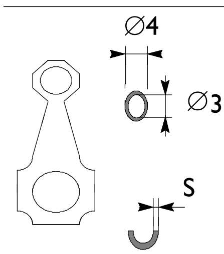
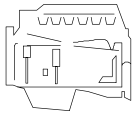
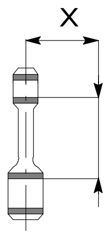
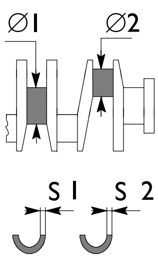
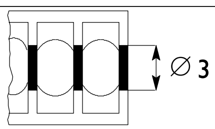
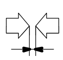
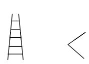
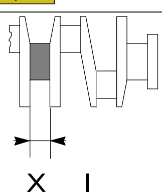
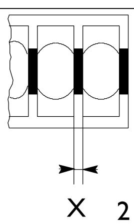
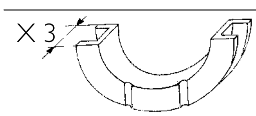
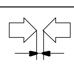
	Type	**F1AE0481A*....**	**F1AE0481B*....**
CYLINDER ASSEMBLY AND CRANK MEMBERS		mm	
	Type of piston	FEDERAL MOGUL	MAHLE MONDIAL
	Piston ring slots X1*	2.197	2.200 ÷ 2.230
	X2	2.040 ÷ 2.060	2.050 ÷ 2.070
	X3	2.520 ÷ 2.540	2.540 ÷ 2.560
	* measured on ∅ of 85 mm		
	Piston rings: S1*	2.068 ÷ 2.097	
	S2	1.970 ÷ 1.990	
	S3	2.470 ÷ 2.490	
	* measured on ∅ of 85 mm		
	Piston rings – slots 1	0.103 ÷ 0.162	
	2	0.060 ÷ 0.100	
	3	0.050 ÷ 0.090	
IVECO PARTS	Piston rings	0.4	
	Piston ring end opening in cylinder liner:		
	X1	0.20 ÷ 0.35	
	X2	0.60 ÷ 0.80	
	X3	0.25 ÷ 0.50	
	Small end bushing seat ∅ 1	34.460 ÷ 34.490	
	Connecting rod bearing seat* ∅ 2	62.833 ÷ 62.841	
	* connecting rod supplied as spare part		
	Small end bushing diameter		
	outside ∅ 4	34.560 ÷ 34.585	
	inside ∅ 3	31.010 ÷ 31.020	
	Big end bearing shells supplied as spare part S	-	
	Small end bushing – seat (interference)	0.07 ÷ 0.125	
	Piston gudgeon pin – bushing	0.014 ÷ 0.030	
IVECO PARTS	Big end bearing shells	0.254 - 0.508	

	Type	**F1AE0481A*....**	**F1AE0481B*....**
CYLINDER ASSEMBLY AND CRANK MEMBERS		mm	
	Measurement X	125	
	Maximum error on alignment of connecting rod axes =	0.09	
	Main journals Ø 1		
	No. 1-2-3-4	71.182 ÷ 71.208	
	No. 5	76.182 ÷ 76.208	
	Crankpins Ø 2	59.015 ÷ 59.038	
	Main bearing shells S1*	2.165 ÷ 2.174	
	Big end bearing shells S2*	1.883 ÷ 1.892	
	* supplied as spare parts		
	Main bearing housings Ø 3		
	No. 1-2-3-4	75.588 ÷ 75.614	
	No. 5	80.588 ÷ 80.614	
	Bearing shells - main journals	0.032 ÷ 0.102	
	Bearing shells – crankpins	0.035 ÷ 0.083	
	Main bearing shells	0.254 ÷ 0.508	
	Big end bearing shells	0.254 ÷ 0.508	
	Main journal for shoulder X 1	31.020 ÷ 31.170	
	Main bearing housing for shoulder X 2	25.790 ÷ 25.840	
	Half thrust washers X 3	30.810 ÷ 30.960	
	Crankshaft shoulder	0.060 ÷ 0.260	

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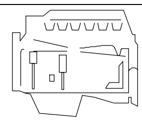
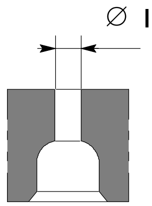
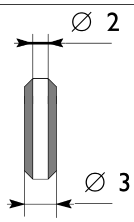
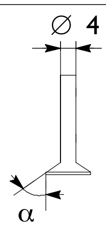
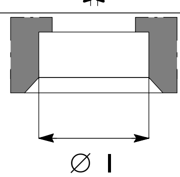
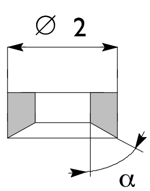
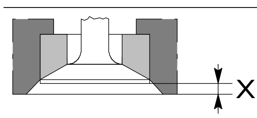
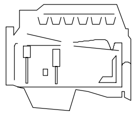
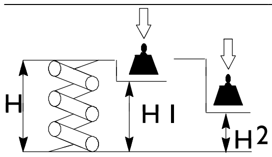
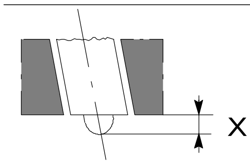
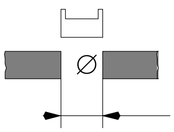
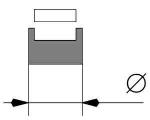
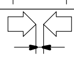
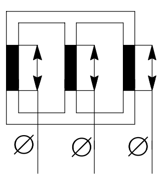
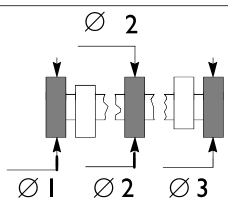
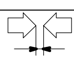
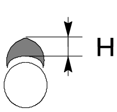
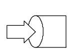
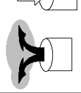
	Type	**F1AE0481A*....**	**F1AE0481B*....**
CYLINDER HEAD – TIMING SYSTEM		mm	
 	Guide valve seats on cylinder head Ø1	9.980 ÷ 10.000	
 	Valve guides Ø 2 Ø 3	6.023 ÷ 6.038 10.028 ÷ 10.039	
	Valve guides and seats on head (interference)	0.028 ÷ 0.059	
	Valve guides	0.05 - 0.10 - 0.25	
 	Valves: Ø 4 α Ø 4 α	5.975 ÷ 5.990 44°45' ±7.5' 5.975 ÷ 5.990 44°45' ±7.5'	
	Valve stem and relevant guide	0.033 ÷ 0.063	
 	Seat on head for valve seat: Ø1 Ø1	31.390 ÷ 31.415 31.390 ÷ 31.415	
 	Outside diameter of valve seats; angle of valve seats on cylinder head: Ø 2 α Ø 2 α	31.495 ÷ 31.510 44.5° ±5' 31.495 ÷ 31.510 44.5° ±5'	
 	Recessing X X	0.5 ÷ 0.8 0.5 ÷ 0.8	
	Between valve seat and head	0.08 - 0.12 0.08 - 0.12	
	Valve seats	-	

	Type	F1AE0481A*....	F1AE0481B*....
			
CYLINDER HEAD – TIMING SYSTEM		mm	
	Valve spring height: free spring H under a load of: N243 ± 12 H1 N533 ± 24 H2	54 45 35	
	Injector protrusion X	2.77 ÷ 3.23	
	Seats for tappets on cylinder head normal ∅	12.016 ÷ 12.034	
	Normal diameter tappets	11.988 ÷ 12.000	
	Between tappets and seats	0.016 ÷ 0.046	
	Camshaft pin seats in cylinder overhead 1 ⇒ 7 ∅ 1 ∅ 2 ∅ 3	 48.987 ÷ 49.013 46.987 ÷ 47.013 35.987 ÷ 36.013	
	Camshaft supporting pins: ∅ 1 ∅ 2 ∅ 3	 48.925 ÷ 48.950 46.925 ÷ 46.950 35.925 ÷ 35.950	
	Supporting pins and seats	0.037 ÷ 0.088	
	Useful cam height  H  H	 3.77 4.203	

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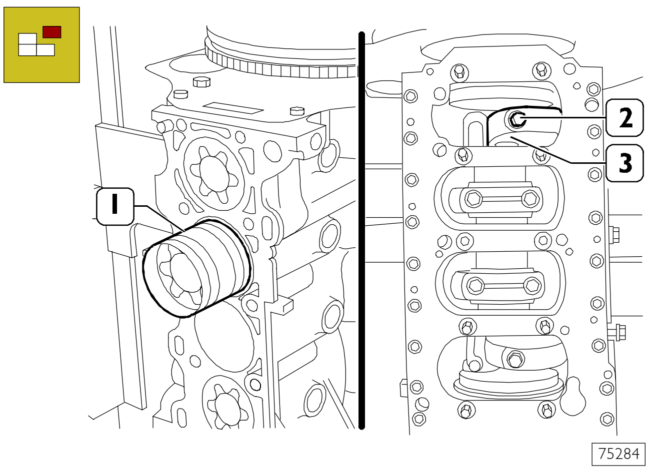
ENGINE OVERHAUL
ENGINE REMOVAL AT THE BENCH

The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).

The section illustrates therefore all the most important engine overhaul procedures.

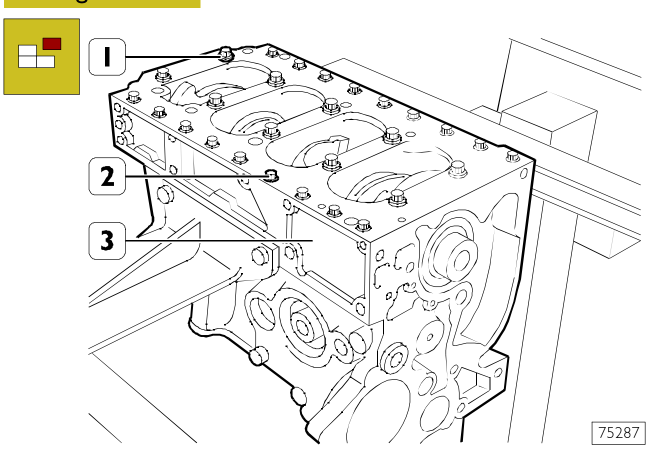
Figure 1



Take out the screws (2) and remove the connecting rod caps (3).
Extract the pistons (1) from the top of the crankcase.

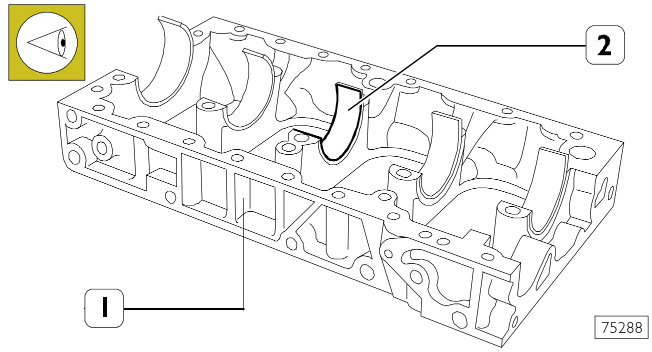
NOTE On the same side of the connecting rod and its associated cap, indicate the number of the cylinder from which the connecting rod has been removed. Keep the bearing shells in their respective housings since, if they are used, they will need to be fitted in the position found during removal.

Figure 2



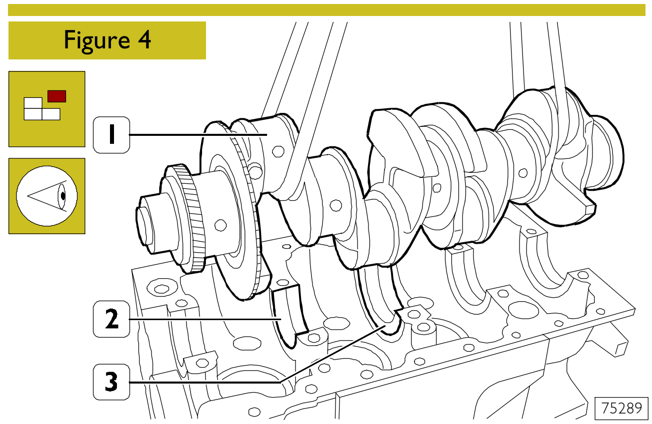
Using an appropriate wrench and a hex-fluted wrench, unscrew the screws (1) and (2) and remove the crankcase base (3).

Figure 3



NOTE Note the assembly position of the bottom main bearing shells (2) since, if they are reused, they will need to be fitted in the position found during removal.

Figure 4

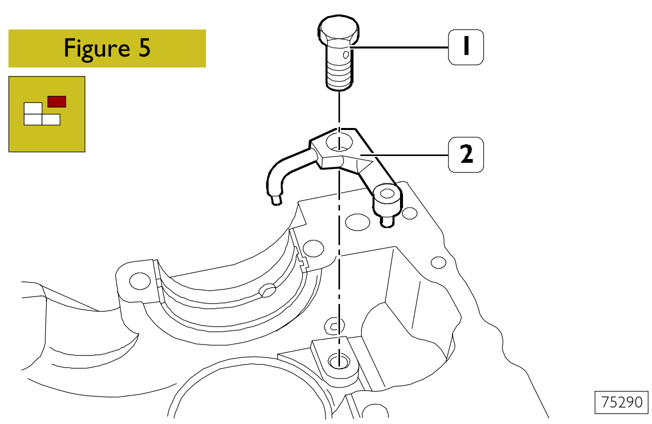


With the aid of a hoist and a rope, remove the crankshaft (1).

NOTE Note the assembly position of the top main bearing shells (2) since, if they are reused, they will need to be fitted in the position found during removal.

The central half ring (3) is fitted with thrust half-washers.

Figure 5

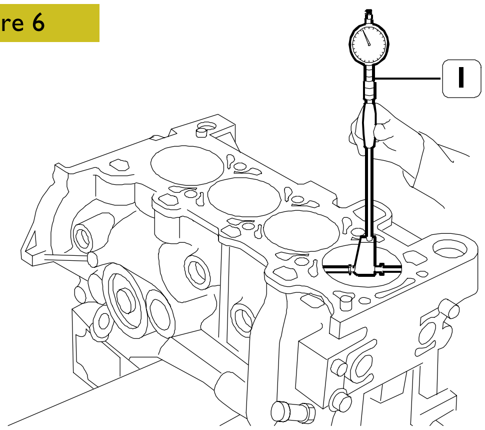


Take out the couplings (1) and remove the oil jets (2).

NOTE On completing engine removal, it is necessary to clean the removed parts thoroughly and check their integrity.
The following pages give the instructions for the main checks and measurements to make in order to determine whether the parts can be reused.

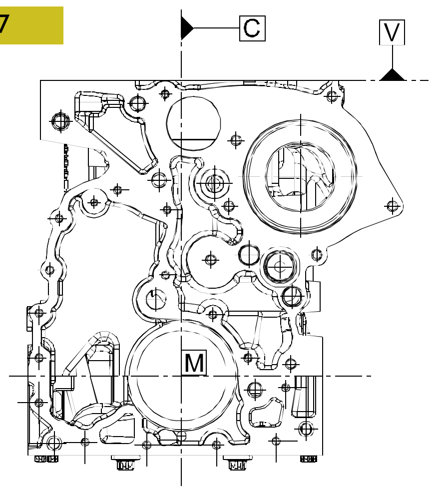
REPAIRS
CYLINDER BLOCK
Checks and measurements

Figure 6



After removing the engine, thoroughly clean the cylinder-crankcase assembly. Use the rings 99365508 to carry the cylinder block.
Carefully check that the crankcase has no cracks in it.
Check the state of the plugs. If they are rusty or there is any doubt about their seal, replace them. Examine the surfaces of the cylinder liners; they must show no sign of meshing, scoring, ovalization, taper or excessive wear. The inside diameter of the cylinder liners is checked, to ascertain the extent of ovalization, taper and wear, using the bore meter 99395687 (1) fitted with a dial gauge previously reset on the ring gauge of the diameter of the cylinder liner or on a micrometer.

Figure 7



* Surface roughness parameters:

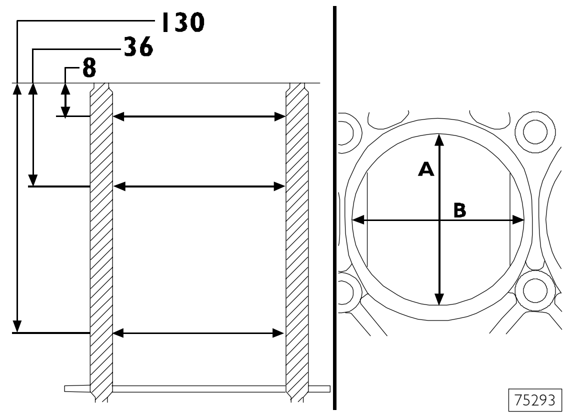
Rt = 4 ÷ 10 µm
Rz = 3 ÷ 8 µm
Ra = 0,25 ÷ 0,6 µm
Wt < 1,5 µm

Permissible surface porosity for machined cylinder (see Figure 9)

ZONE B1 = Area of greatest mechanical stress, segment/liner contact: No.2 non-continuous porosities are permissible max. 0.5x0.5. C 100%

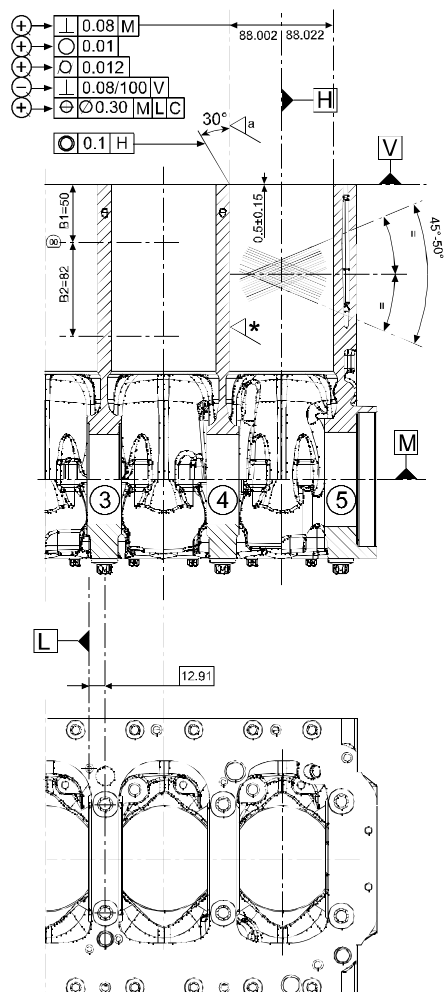
ZONE B2 = Surface involved in segment rubbing: No.2 non-contiguous porosities are permissible max. 1x0.8. C 100%

Figure 8



The measurements must be made for each single cylinder at three different heights up the liner and on two planes at right angles to each other: one parallel to the longitudinal axis of the engine (B) and the perpendicular (A); the greatest wear is generally found on this last plane with the first measurement.
On finding ovalization, taper or wear, go ahead and bore/grind and finish the face of the cylinder liners. The refacing of the cylinder liners should be done in relation to the diameter of the pistons supplied as spare parts oversized by 0.4 mm of the nominal value and to the prescribed assembly clearance.

Figure 9



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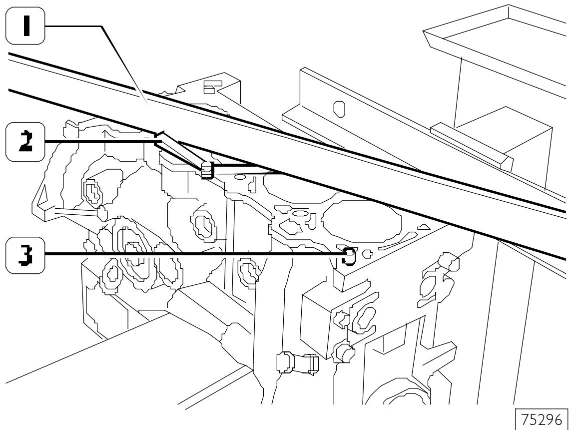
Checking head mating surface on cylinder block

Figure 10

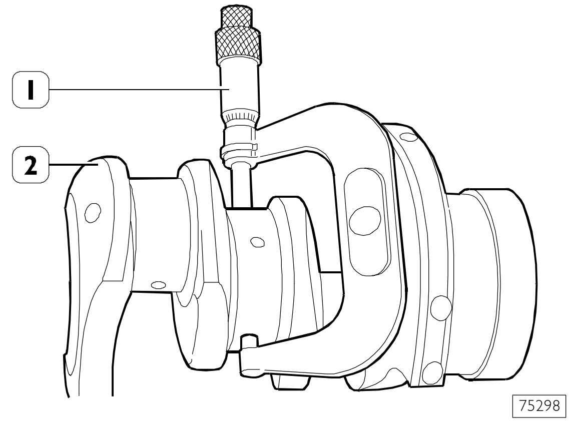


See that the head mating surface, on the cylinder block, has no deformation.
This check can be made, after taking out the grub screws (3), with a surface plate spread with carbon black or with a calibrated rule (1) and a feeler gauge (2). After ascertaining the areas of deformation, level the bearing surface with a grinding machine.

NOTE The crankcase can only be surfaced after making sure that, on completing the work, the piston protrudes from the cylinder liner by no more than the prescribed value.

CRANKSHAFT
Measuring main journals and crank pins

Figure 12



On finding signs of seizure, scoring or excessive ovalization on main journals and crankpins, it is necessary to regrind the pins. Before grinding the pins (2), measure the shaft pins with a micrometer (1) to establish to what diameter it is necessary to decrease the pins.

NOTE It is advisable to enter the measurements in a table. See Figure 11.

Figure 11

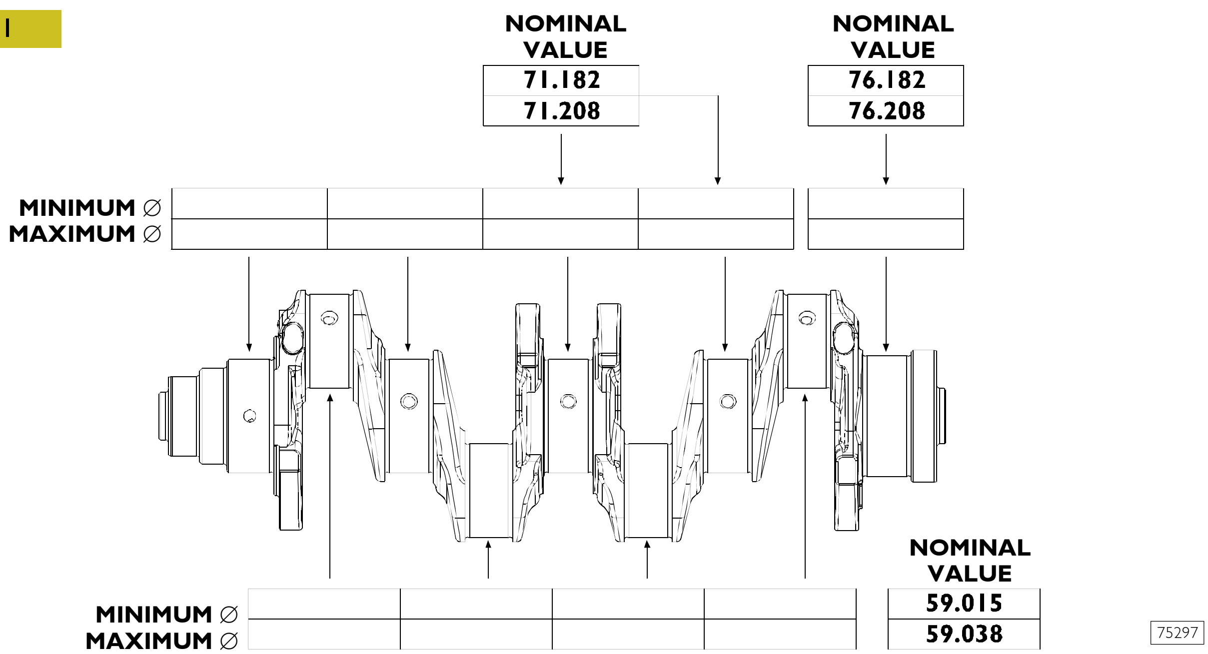


TABLE IN WHICH TO ENTER THE MEASUREMENTS OF THE CRANKSHAFT MAIN JOURNALS AND CRANKPINS

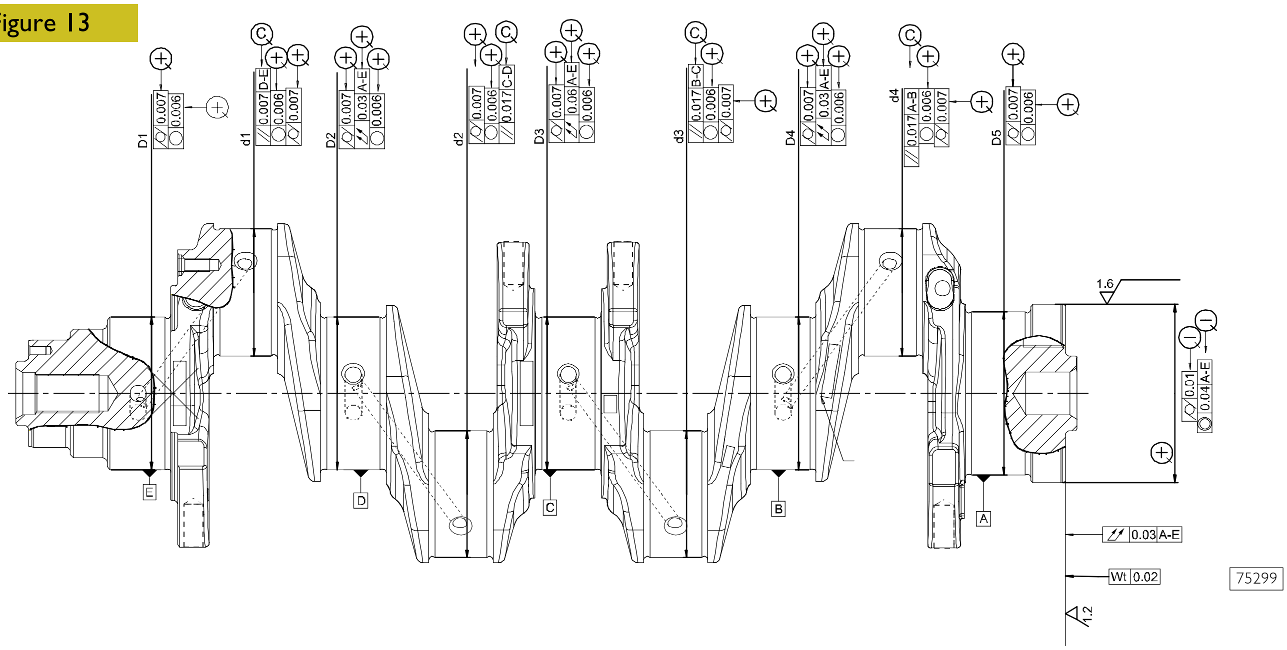
NOTE The main journals and crankpins must always be ground to the same undersize class.
The undersizing performed, on the main journals or crankpins, must be marked by punching on the side of crank arm no. 1.

For undersized crankpins, letter M.
For undersized main journals, letter B.
For undersized crankpins and main journals, letter MB.

The undersize classes are:
0.254 – 0.508 mm.

Checking crankshaft

Figure 13

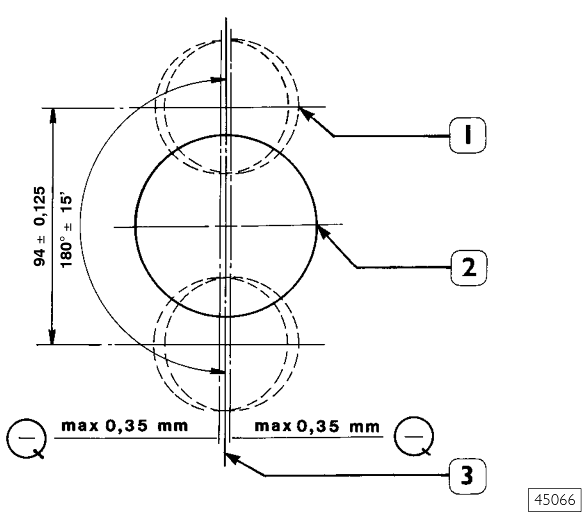


MAIN CRANKSHAFT TOLERANCES

TOLERANCES	TOLERANCE CHARACTERISTIC	SYMBOL
SHAPE	Circularity	○
	Cylindricality	⌭
DIRECTION	Parallelism	//
	Perpendicularity	⊥
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰

CLASS OF IMPORTANCE ASCRIBED TO THE PRODUCT CHARACTERISTICS	SYMBOL
CRITICAL	©
IMPORTANT	⊕
SECONDARY	⊖

Figure 14



NOTE The checks on the tolerances indicated in the figures must be made after grinding the crankshaft pins.

SYMMETRY BETWEEN MAIN JOURNALS AND CRANKPINS

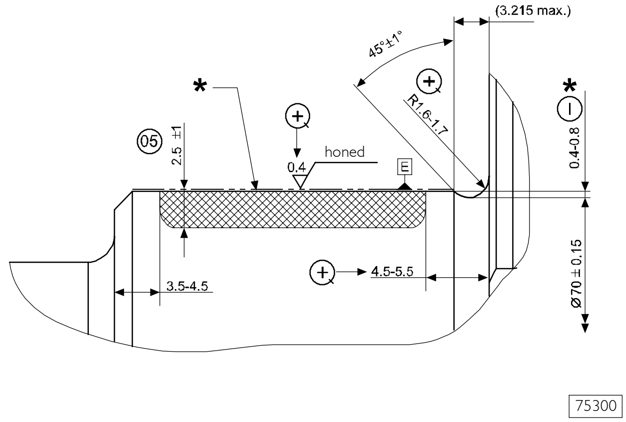
1. Crankpins
2. Main journals
3. Normal position

After grinding, keep to the following:

❑ Round off the edges of deburring the holes for lubrication of the main journals and crankpins.

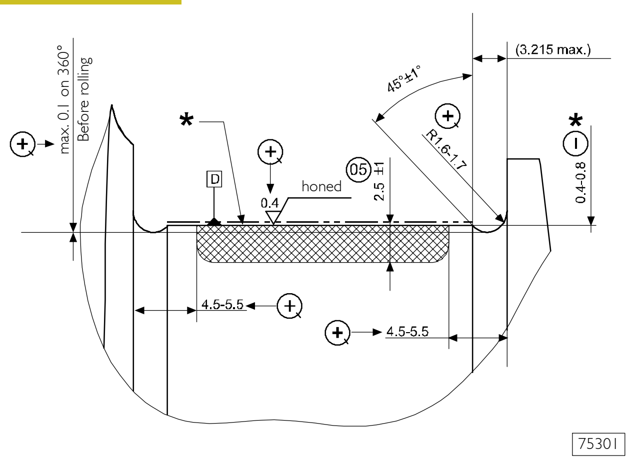
JOURNAL ON TIMING SYSTEM SIDE

Figure 15



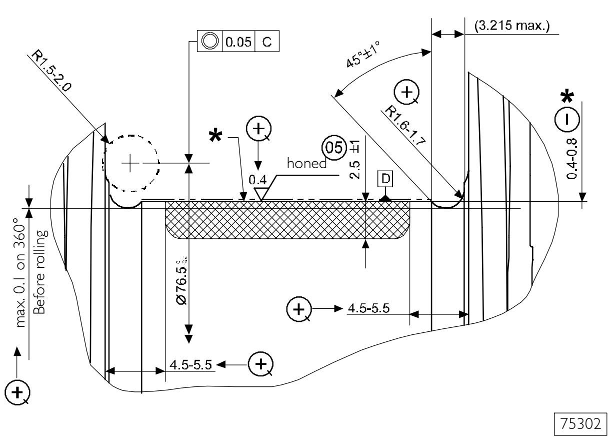
INTERMEDIATE JOURNALS No. 2-4

Figure 16



INTERMEDIATE JOURNAL No. 3

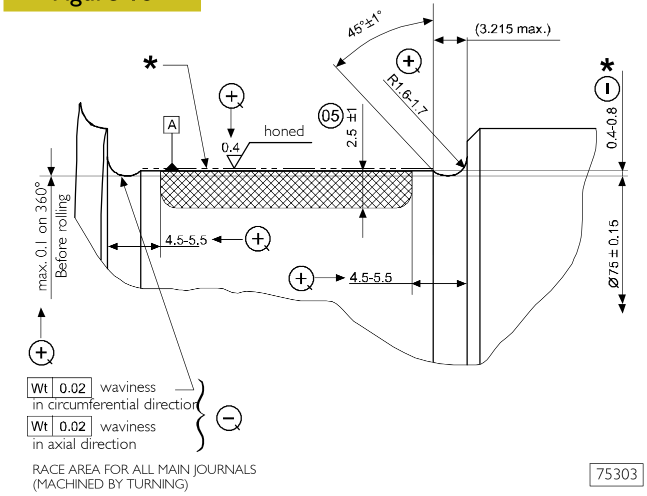
Figure 17



MAIN DATA OF MAIN JOURNALS AND CRANKPINS

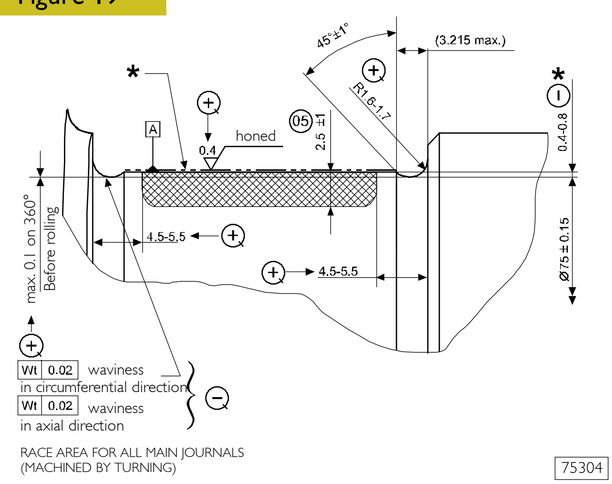
JOURNAL ON FLYWHEEL SIDE

Figure 18



CRANKPINS

Figure 19



* On both races, on all 360°.

NOTE Since, during the 0.254 and 0.508 mm undersizing on the diameter of the crankpins and main journals, the rolled portion of the side races of the pins may get involved, it is necessary to turn the races keeping to the data given in the figure and to do the rolling keeping to the following instructions.

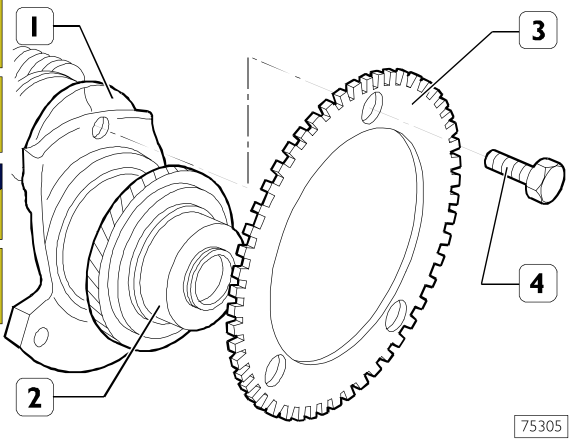
Rolling force:

- ❑ 1^{st} main journal 925 ±25 daN.
- ❑ 2^{nd} – 3^{rd} – 4^{th} – 5^{th} main journal 1850 ±50 daN.
- ❑ crankpin 1850 ±50 daN.

- ❑ Rolling turns: 3 approach, 12 effective, 3 out.
- ❑ Rolling speed: 56 rpm.
- ❑ Decrease in crankpin race depth after rolling: 0.15 – 0.30 mm*.
- ❑ Decrease in main journal race depth after rolling: 0.15 – 0.30 mm*.

* Measured with calibrated rollers Ø 2.5 mm.

Figure 20



Take out the screws (4) and replace the phonic wheel (3). The screws (4) are coated with LOCTITE 218 and must be replaced with fresh ones after each disassembly.
They must be tightened to a torque of 15 Nm.

Replacing timing control gear

On finding the timing control gear teeth (1) damaged or worn, remove them from the crankshaft (2) using a suitable extractor.

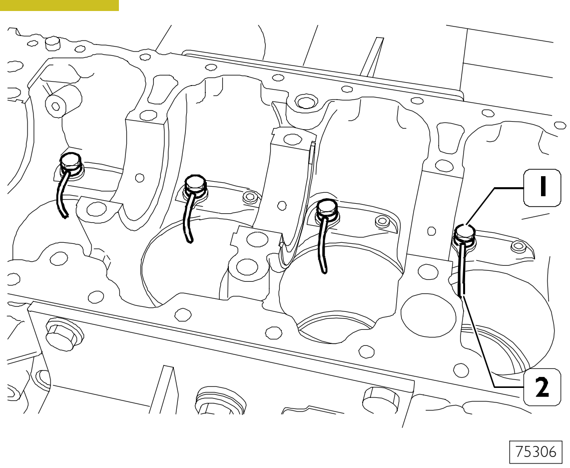
The new gear is fitted onto the crankshaft by heating it to a temperature of 200°C for no longer than 15 minutes.

On completing assembly and after the gear has cooled, it must withstand a torque of 150 Nm without slipping.

ENGINE ASSEMBLY

The following parts must be replaced with new ones at the time of assembly: retaining rings, seals and gaskets, screws whose thread is coated with sealant.

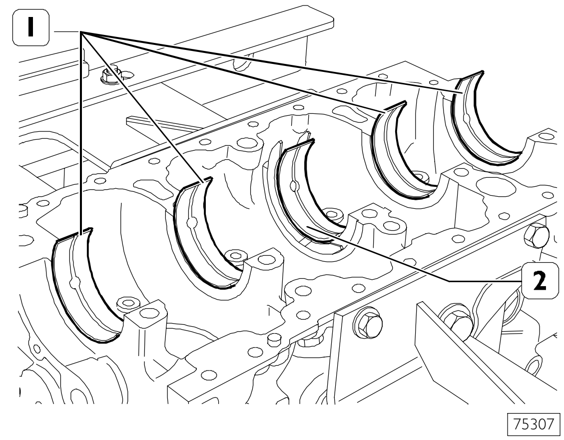
Figure 21



Fit on the oil spray nozzles (2) and tighten the couplings (1) to the prescribed torque.

Assembling main bearings

Figure 22



NOTE Not having found it necessary to replace the main bearings, they need to be fitted back on in the same sequence and position found upon disassembly.

The main bearings (1) are supplied as spare parts undersized on the inside diameter by 0.254 ÷ 0.508 mm.

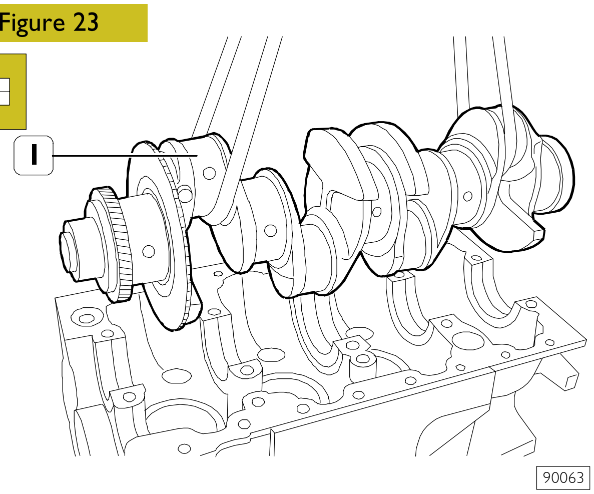
NOTE Do not do any accommodating on the bearings.

Thoroughly clean the top main bearing shells (1) and position them in the crankcase.

NOTE The middle half ring (2) is fitted with thrust washers.

Measuring main journal assembly clearance

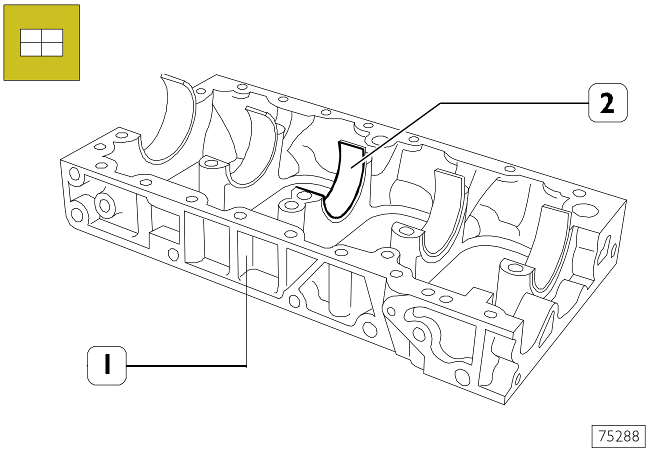
Figure 23



Mount the crankshaft (1).
Check the clearance between the crankshaft main journals and their respective bearings by proceeding as follows:

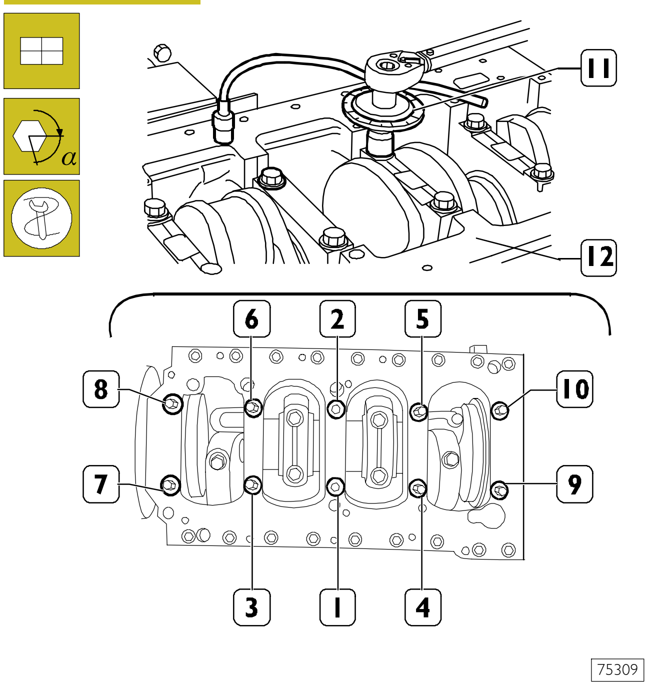
- ❑ Thoroughly clean the pins.
- ❑ Apply a calibrated wire onto the main journals.

Figure 24



Thoroughly clean the bottom main bearing shells (2) and mount them in the crankcase base (1).

Figure 25



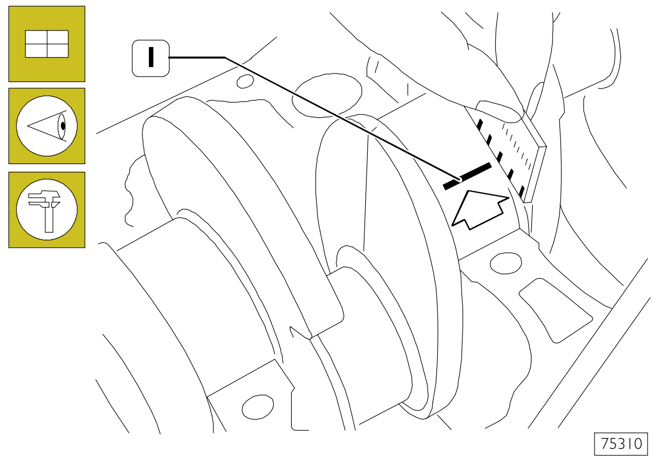
Mount the crankcase base (12).

Tighten the screws in the sequence shown in the figure in three steps:

- Step 1: with a torque wrench, to a torque of 50 Nm.
- Step 2: closing to an angle of 60°.
- Step 3: closing to an angle of 60°.

NOTE Use tool 99395216 (11) for the angle closing.

Figure 26

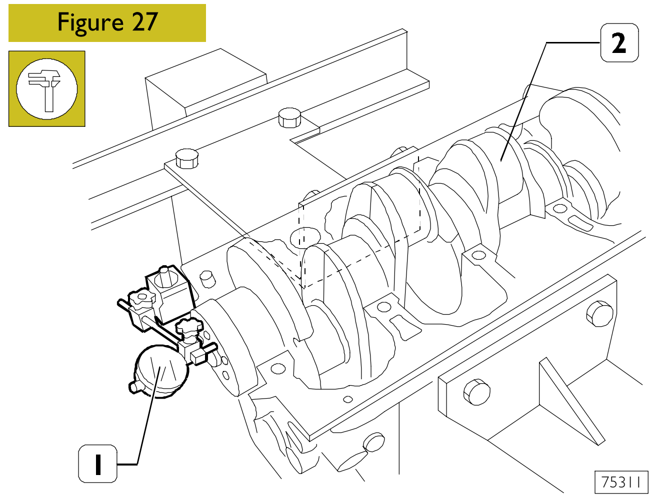


- Remove the bottom crankcase.

The clearance between the main bearings and their associated pins is measured by comparing the length of the calibrated wire (1), at the point of greatest crushing, with the graduated scale on the casing containing the calibrated wire. The numbers on the scale indicate the clearance of the coupling in millimetres, which must be 0.032 ÷ 0.102 mm. If the clearance is not as prescribed, replace the bearings and repeat the check.

Checking crankshaft end float

Figure 27



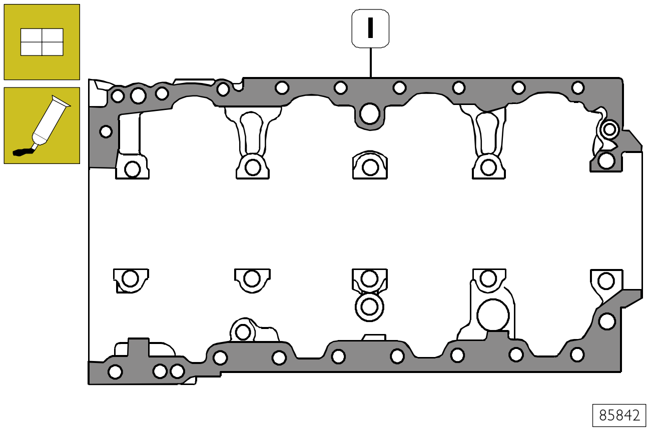
The end float is checked by setting a dial gauge (1) with a magnetic base on the crankshaft (2) as shown in the figure. The normal assembly clearance is 0.060 – 0.310 mm.

If you find the clearance to be greater than as required, replace the rear main bearing shells carrying the thrust bearings and repeat the clearance check between the crankshaft pins and the main bearing shells.

If the end float of the crankshaft does not come within the prescribed values, it is necessary to grind the crankshaft and accordingly change the main bearing shells.

NOTE: The middle main bearing has half thrust washers integrated in it, so it performs the function of a thrust bearing. It is supplied as a spare part only with the normal shoulder thickness.

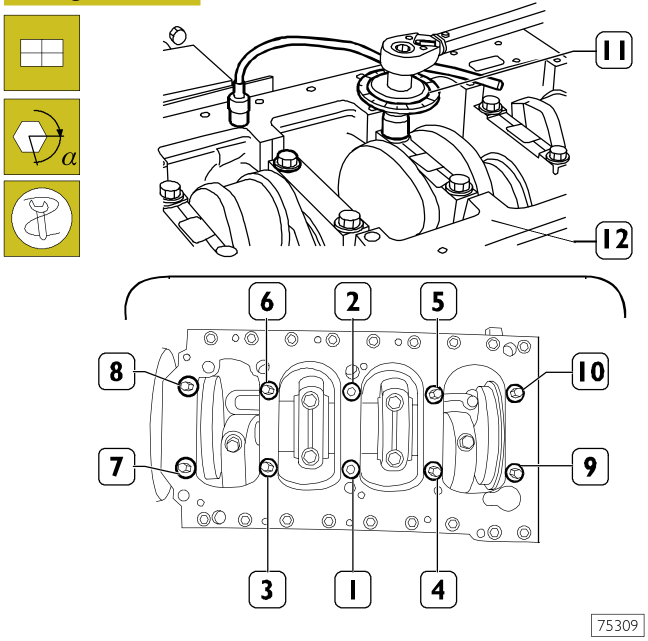
Figure 28



Thoroughly clean the crankcase / crankcase base mating surface.
Apply, on base, sealant LOCTITE 510 IVECO no. 93162432, as indicated in the scheme. The sealant must result to be even, not patchy.

NOTE Mount the crankcase base within 10 minutes of applying the sealant.

Figure 29

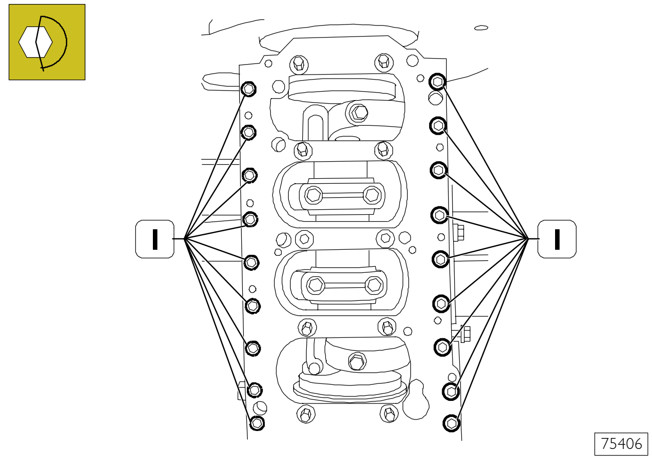


Mount the crankcase base (12) and tighten the fixing screws in three stages, following the sequence shown in the figure:

- Step 1: with a torque wrench, to a torque of 50 Nm.
- Step 2: closing to an angle of 60°.
- Step 3: closing to an angle of 60°.

NOTE Use tool 99395216 (11) for the angle closing.

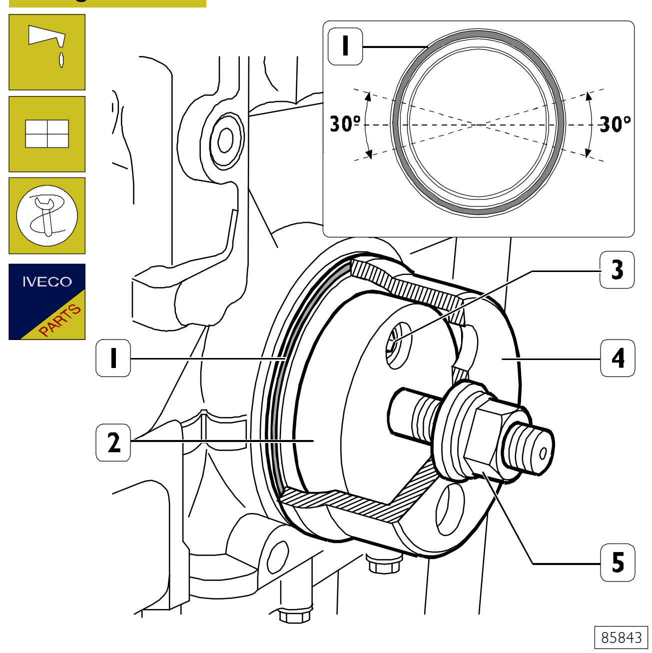
Figure 30



Then tighten the outer screws (1) to a torque of 36 – 30 Nm.

Assembling rear seal

Figure 31



Carefully clean the seal seat. Apply LOCTITE 510 IVECO nr. 2992504 on the seal (1) for 30° in the points shown in the figure.
Lubricate the rear shank of the crankshaft with engine oil.
Fit part (2) of tool 99346255 onto the rear shank of the crankshaft; secure it with the screws (3) and key the fresh seal (1) onto it.
Position part (4) on part (2); screw down the nut (5) to fit the seal (1) fully inside the crankcase.

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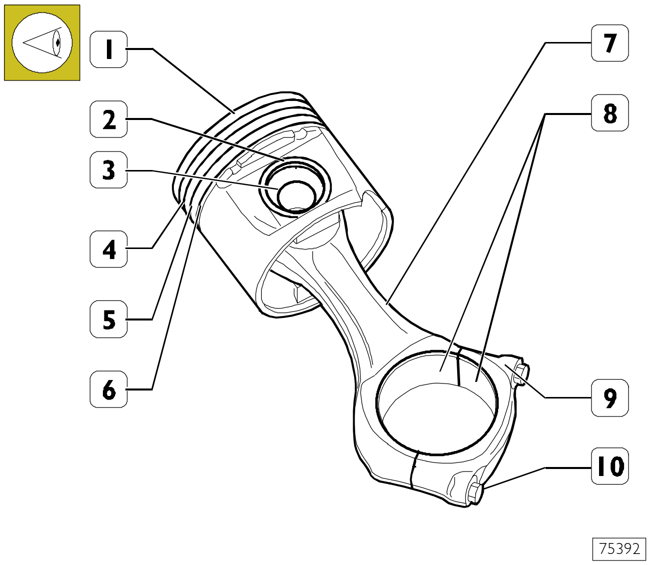
CONNECTING ROD – PISTON ASSEMBLY

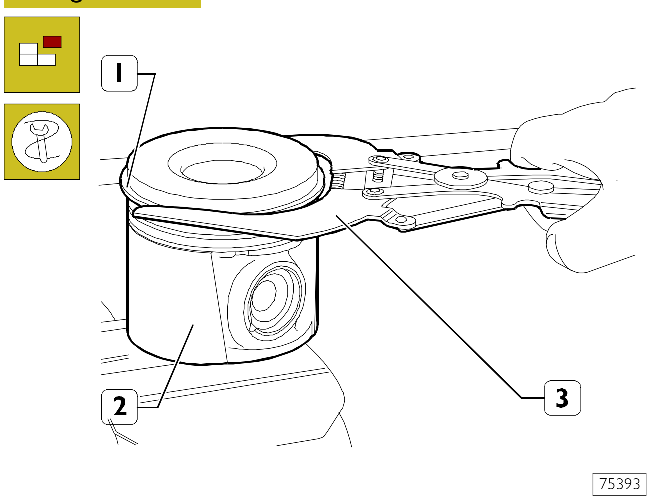
Figure 32



PISTON – CONNECTING ROD ASSEMBLY
1. Piston – 2. Piston ring – 3. Pin – 4. Trapezoidal ring – 5. Oil scraper ring – 6. Slotted oil scraper ring with spiral spring – 7. Connecting rod body – 8. Bearing shells – 9. Connecting rod cap – 10. Cap fixing screws.

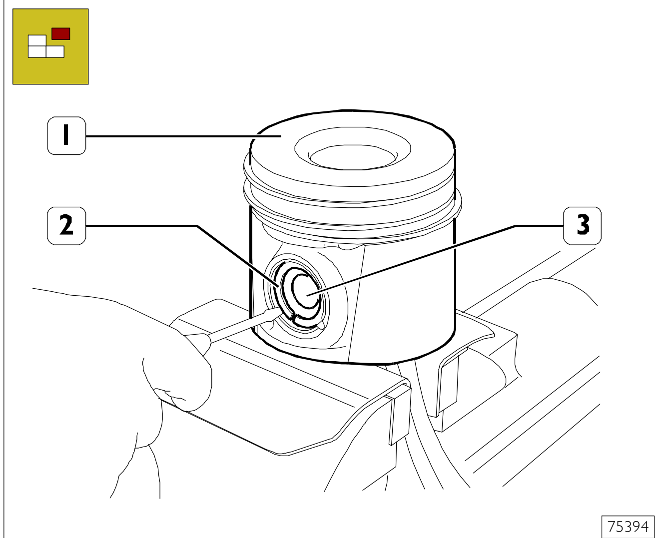
Check the pistons. They must show no signs of seizure, scoring, cracking or excessive wear; replace them if they do.

Figure 33



Remove the piston rings (1) from the piston (2) using pliers 99360183 (3).

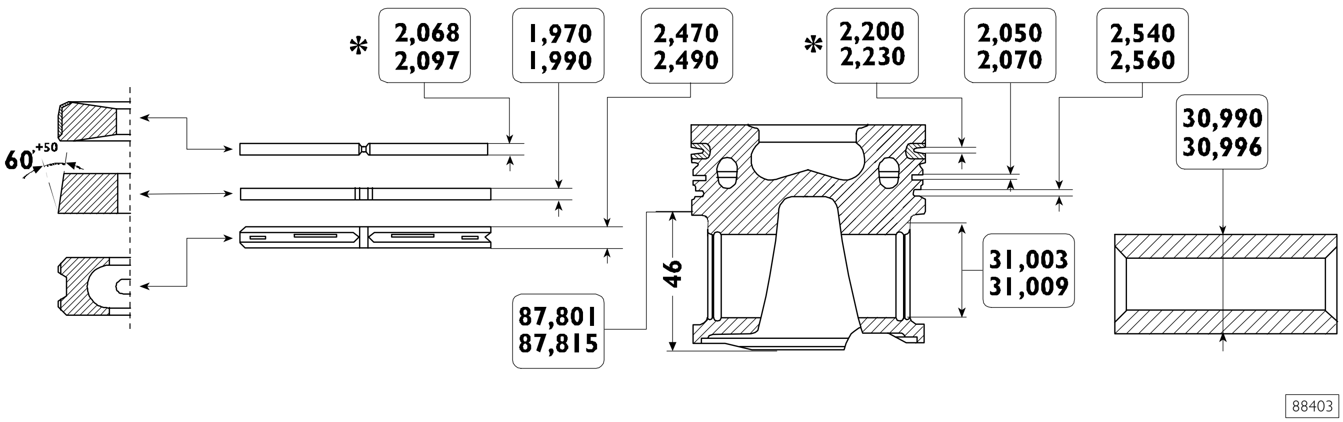
Figure 34



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance. The diameter has to be measured at the value shown.

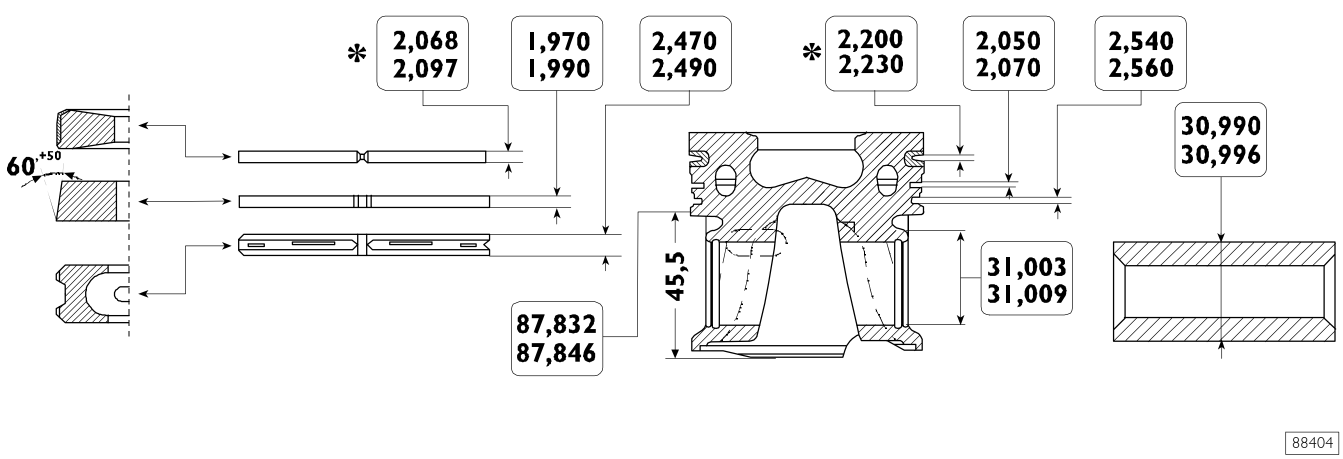
Pistons
Measuring piston diameter

Figure 35



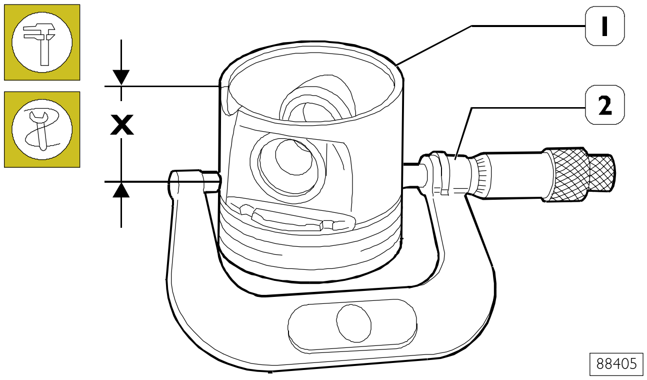
MAIN DATA ON PISTON FEDERAL MOGUL, PINS AND SPRING RINGS
ENGINE F1AE 0481A (96 HP)
* Measured on the diameter of 85 mm.

Figure 36



MAIN DATA ON PISTON MAHLE MONDIAL, PINS AND SPRING RINGS
ENGINE F1AE 0481B (116 HP)
* Measured on the diameter of 85 mm.

Figure 37

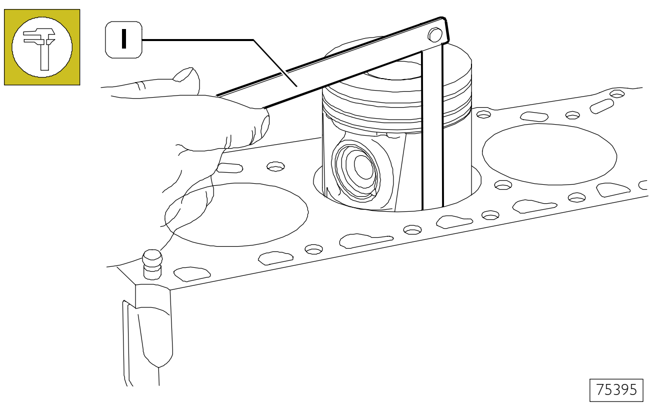


By means of micrometer (2), measure the diameter of piston (1) to determine mounting clearance; the diameter must be detected at distance X from piston base:

- 46 mm - engine F1AE0481A (96 HP)
- 45.5 mm - engine F1AE0481B (116 HP).

NOTE The pistons are supplied as spare parts with the standard, normal and 0.4mm oversize diameters together with rings, pin and retaining rings.

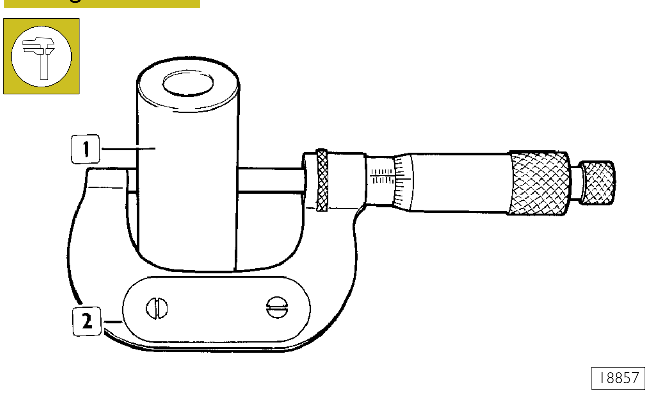
Figure 38



The clearance between the piston and cylinder liner can also be checked using a feeler gauge (1) as illustrated in the figure.

Piston pins

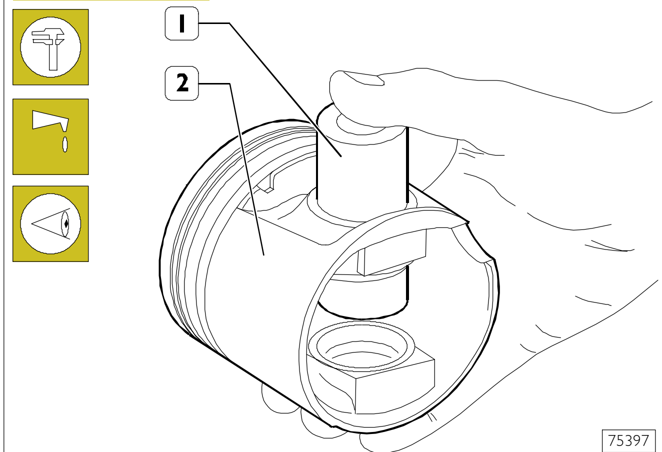
Figure 39



Measuring the diameter of the piston pin (1) with a micrometer (2).

Conditions for correct pin-piston coupling

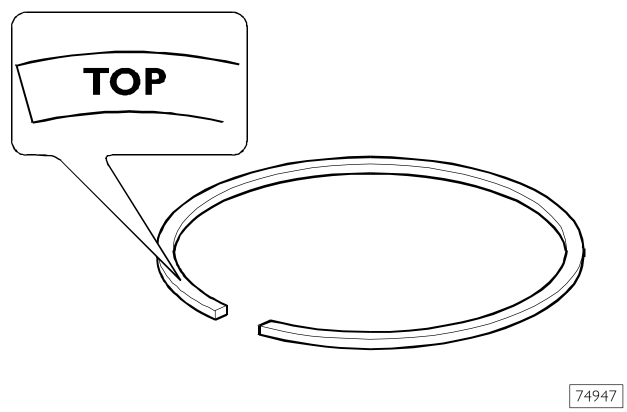
Figure 40



Lubricate the pin (1) and its seat on the hubs of the piston (2) with engine oil. The pin must go into the piston by lightly pressing with the fingers and must not drop out by gravity.

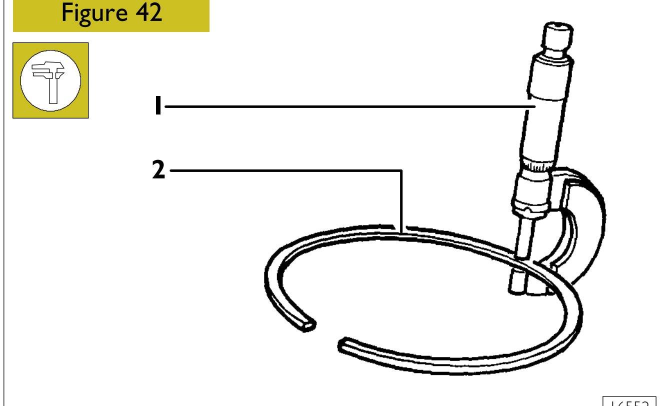
Piston rings

Figure 41



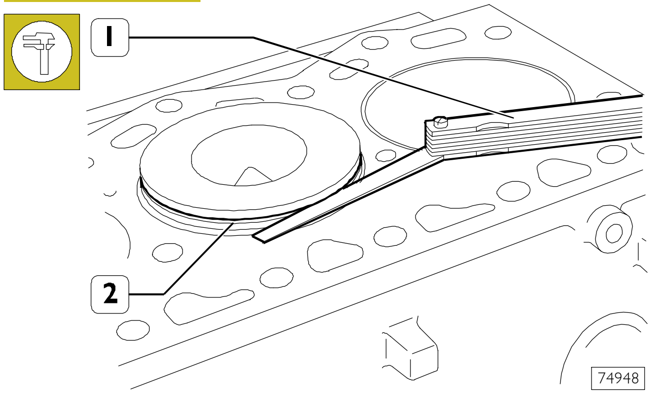
The trapezoidal split rings (1st slot) and the oil scraper rings (2nd slot) have the word TOP etched in them; when fitting them on the piston, the word TOP must be facing upwards.

Figure 42



Check the thickness of the piston rings (2) with a micrometer (1).

Figure 43



Check the clearance between the trapezoidal ring (2) (1st slot) and the associated slot on the piston with a feeler gauge (1), proceeding as follows: insert the piston into the cylinder liner so that the ring (2) comes approximately half way out of it.

Figure 44

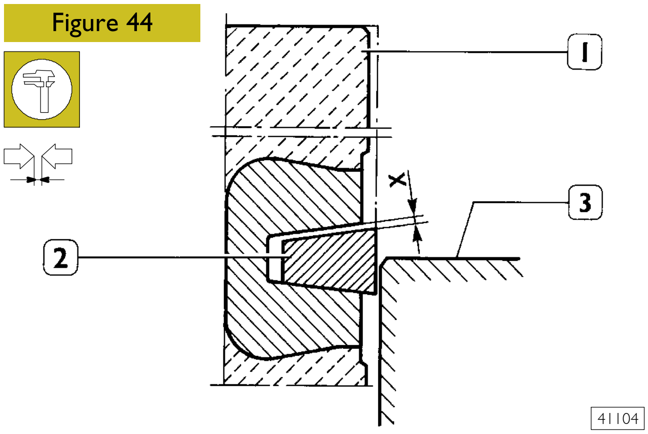
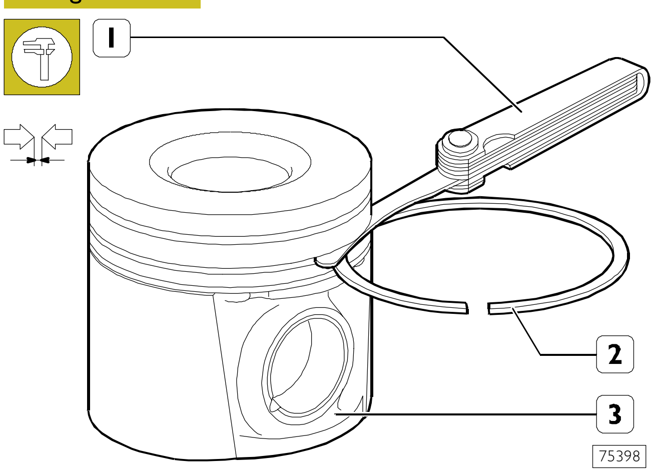


DIAGRAM FOR MEASURING THE CLEARANCE X BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL RING
1. Piston slot – 2. Trapezoidal piston ring – 3. Cylinder liner.

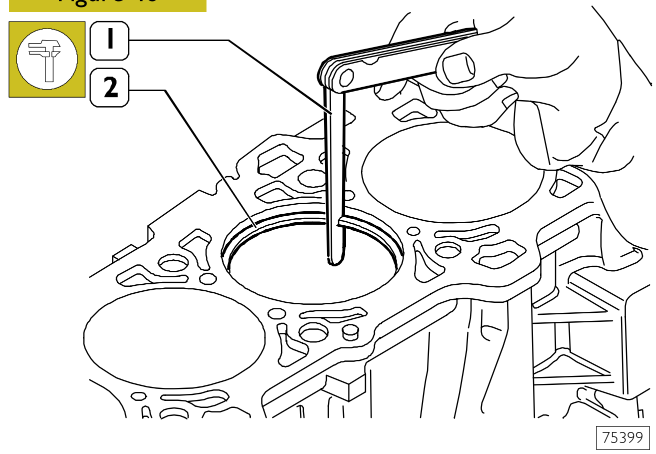
Using a feeler gauge (1, Figure 43), check the clearance (X) between the ring (2) and the slot (1); this clearance must have the prescribed value.

Figure 45



Check the clearance between the piston rings (2) of the 2nd and 3rd slot and the associated seats on the piston (3) with a feeler gauge (1).

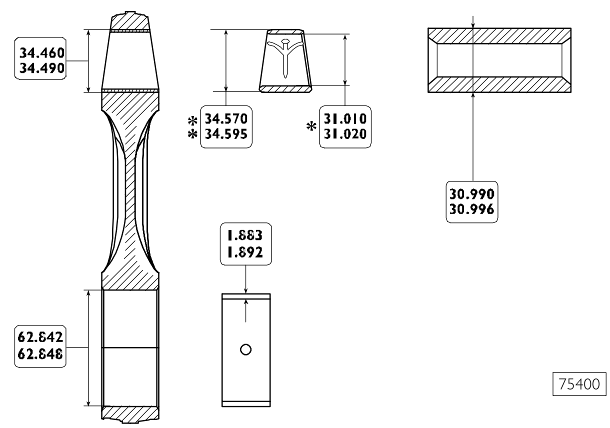
Figure 46



Check the opening between the ends of the piston rings (2) inserted in the cylinder liner using a feeler gauge (1).

Connecting rods

Figure 47



MAIN DATA OF THE CONNECTING ROD, BUSHING, PISTON PIN AND BEARING SHELLS

* Internal diameter to obtain after driving into the small end and grinding with a reamer.
** Dimension cannot be measured in the free state.
*** Thickness of the bearing shell supplied as a spare part.

NOTE Each connecting rod has its cap marked:

- with a letter: O or X indicating the diameter class of the big end mounted in production;

- with a number indicating the weight class of the connecting rod mounted in production.

In addition, it could be stamped with the number of the cylinder in which it is fitted.

In the event of replacement it is therefore necessary to number the new connecting rod with the same number as the one replaced.

The numbering must be done on the opposite side to the bearing shell retaining slots.

The connecting rods are supplied as spare parts with the diameter of the big end 62.842 – 62.848 mm marked with the letter O and the weight class marked with the number 33.

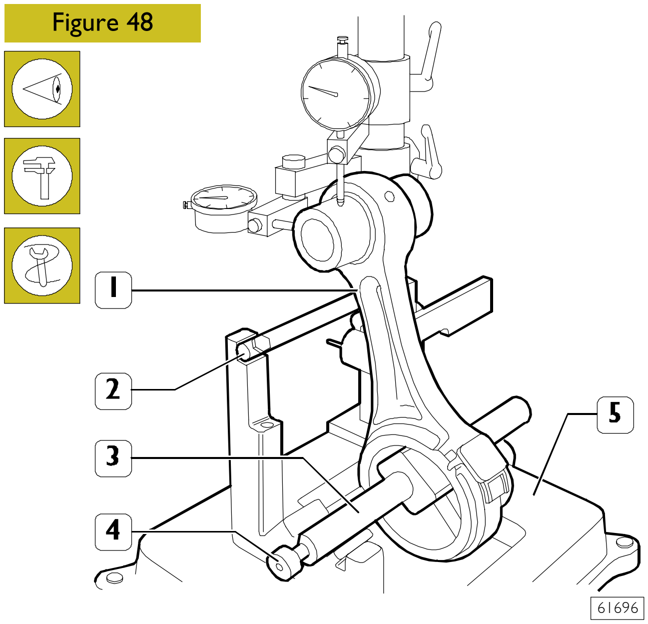
It is not permissible to remove material.

Bushes

Check that the bush in the small end has not come loose and shows no sign of seizure or scoring. If it does, replace the complete connecting rod.

Checking connecting rods

Figure 48

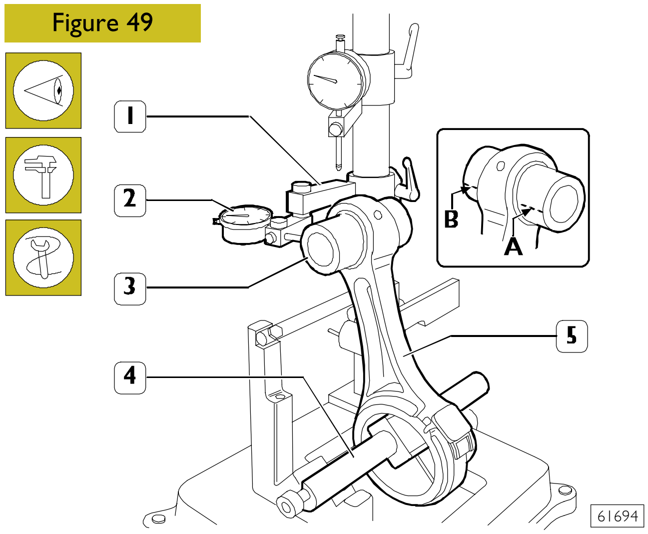


Check the alignment of the axes of the connecting rods (1) with device 99395363 (5), proceeding as follows:

- ❑ Fit the connecting rod (1) on the spindle of the tool 99395363 (5) and lock it with the screw (4).
- ❑ Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion

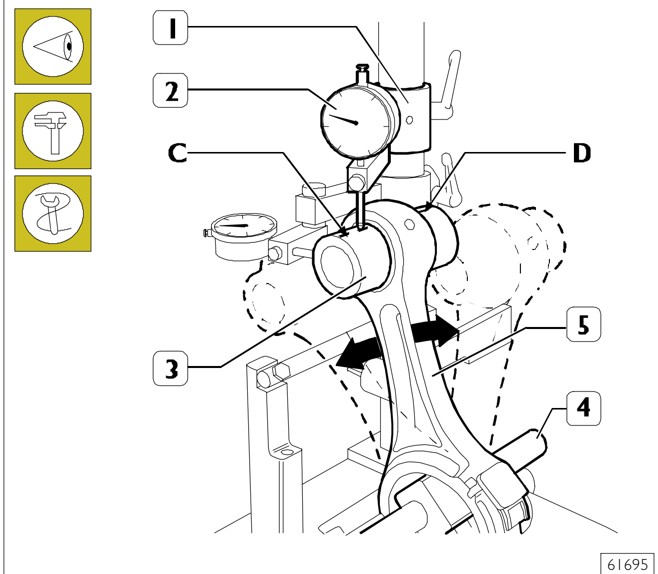
Figure 49



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point A and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side B of the pin (3): the difference between A and B must be no greater than 0.08 mm.

Checking bending

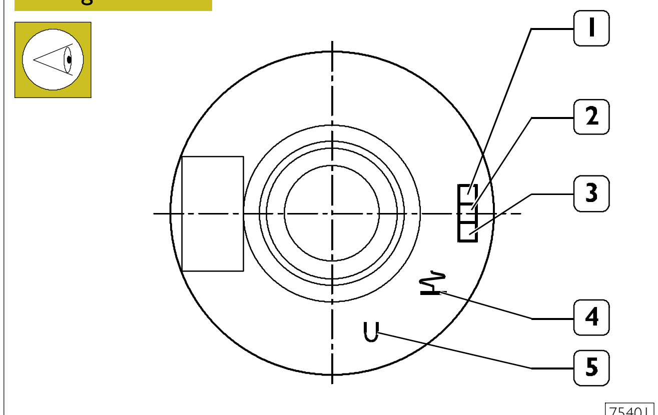
Figure 50



Check the bending of the connecting rod (5) by comparing two points C and D of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point C.
Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2).
Shift the spindle with the connecting rod (5) and repeat the check on the highest point on the opposite side D of the pin (3). The difference between point C and point D must be no greater than 0.08 mm.

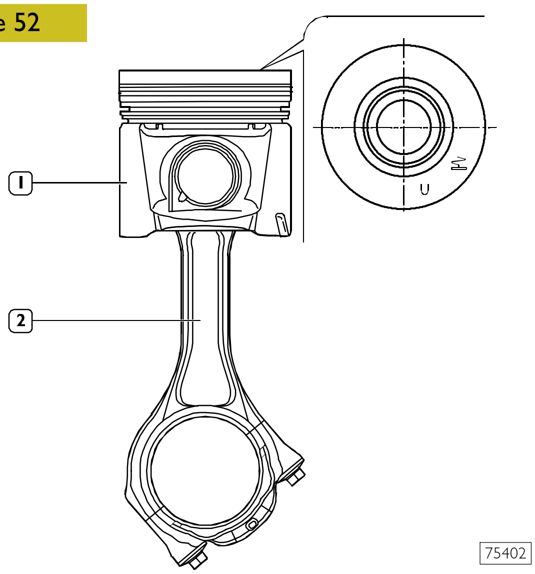
Assembling connecting rod-piston assembly

Figure 51



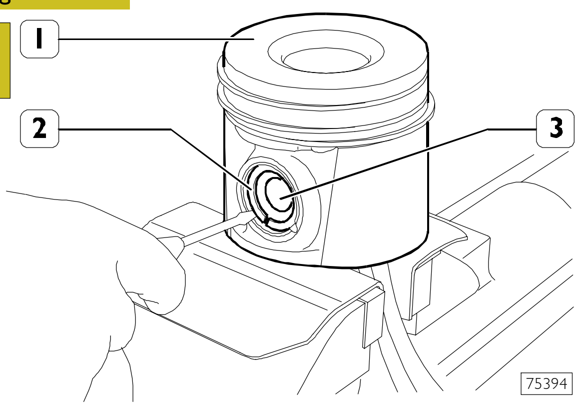
Etched on the top of the piston are: the type of engine (1), class selection (2) and supplier (3) as well as the direction of fitting the piston in the cylinder liner (4). The mark (5) is for passing the 1st slot insert adhesion test.

Figure 52



Connect the piston (1) to the connecting rod (2) together with its cap so that the piston assembly reference, position of the connecting rod and of the cap are observed as shown in the figure.

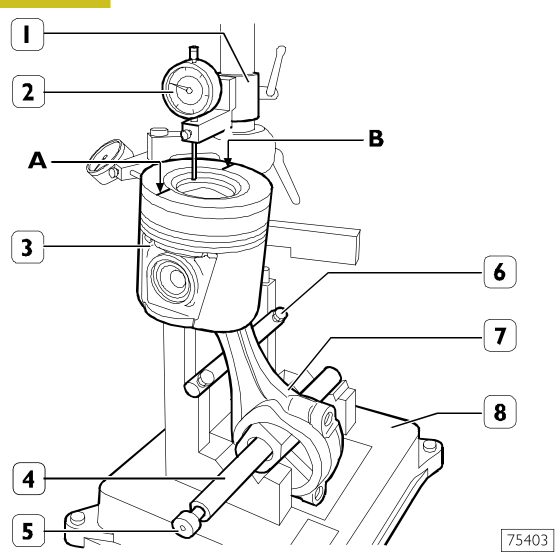
Figure 53



Position the piston (1) on the connecting rod, insert the pin (3) and secure it with the split rings (2).

Checking for connecting rod – piston distortion

Figure 54

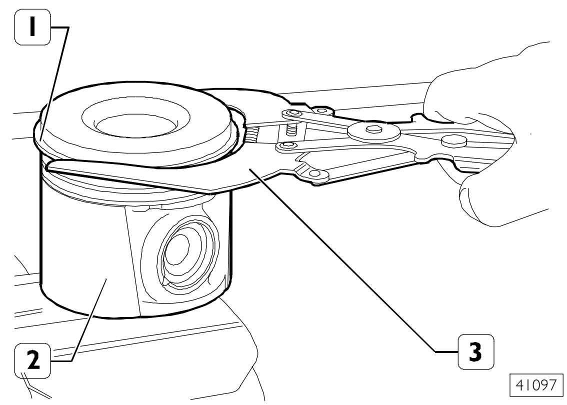


After fitting the connecting rod – piston assembly together, check for distortion with the tool 99395363 (8) as follows:

- Fit the connecting rod (7) together with the piston (3) on the spindle (4) of tool 99395363 (8) and lock it with the screw (5).
- Rest the connecting rod (7) on the bar (6).
- Position the mount (1) of the dial gauge (2) so that this is positioned at point A of the piston with a pre-load of 0.5 mm and zero the dial gauge (2).
- Shift the spindle (4) so as to position the dial gauge (2) at point B of the piston (3) and check for any deviation.

Assembling piston rings

Figure 55

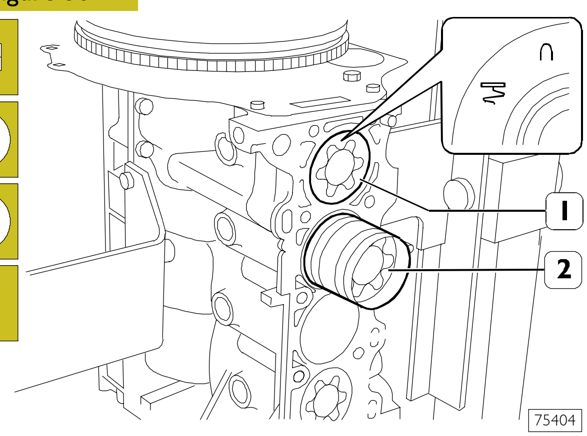


Fit the piston rings (1) on the piston (2) using the pliers 99360183 (3).

NOTE The 1st and 2nd slot rings need to be mounted with the word "TOP" facing upwards.

Assembling connecting rod – piston assemblies in cylinder barrels

Figure 56



Lubricate the pistons well, including the piston rings and the inside of the cylinder liners.
With the aid of the clamp 99360605 (2), fit the connecting rod – piston assembly (1) in the cylinder liners, checking that:

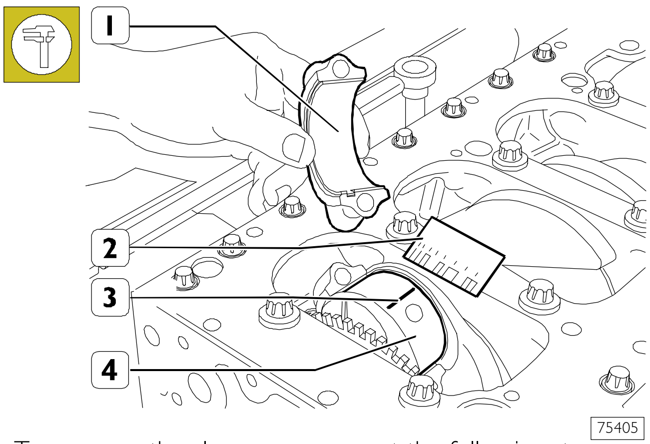
- The number of each connecting rod corresponds to the cap mating number.

- ❑ The openings of the piston rings are staggered 120° apart.
- ❑ The pistons are all of the same weight.
- ❑ The symbol punched on the top of the pistons faces the engine flywheel, or the recess in the skirt of the pistons tallies with the oil spray nozzles.

NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position found on disassembly.

Measuring crankpin assembly clearance

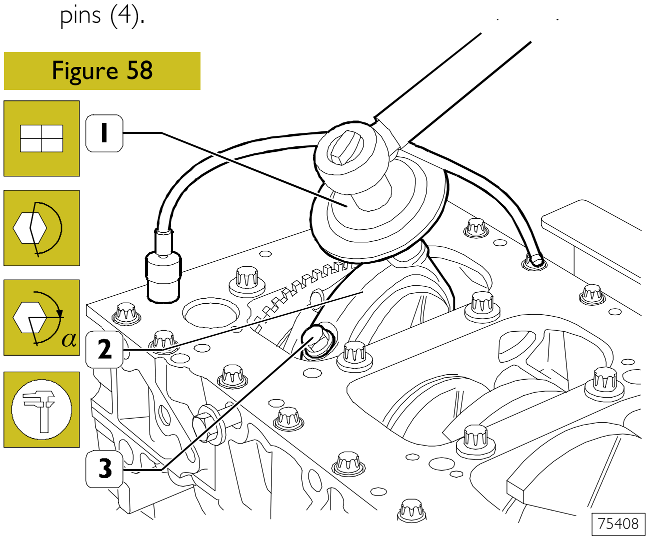
Figure 57



To measure the clearance, carry out the following steps:

- ❑ Thoroughly clean parts (1) and (4) and eliminate all traces of oil.
- ❑ Place a length of calibrated wire (3) on the crankshaft pins (4).

Figure 58



- ❑ Fit the connecting rod caps (2) with the associated bearing shells.
- ❑ Tighten the screws (3) in two steps:
  - Step 1: with a torque wrench, to a torque of 50 Nm.
  - Step 2: closing to an angle of 60°.

NOTE Use tool 99395216 (1) for the angle closing.

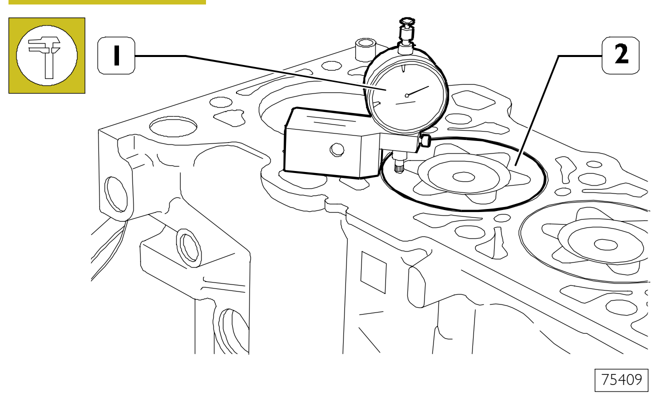
- ❑ Remove the cap (2) and determine the existing clearance by comparing the width of the calibrated wire (3, Figure 57) with the graduated scale on the case (2, Figure 57) that contained the calibrated wire. On finding a clearance other than as prescribed, replace the bearing shells and repeat the check.
  On obtaining the prescribed clearance, lubricate the connecting rod bearing shells and fit them permanently by tightening the connecting rod cap fixing screws as described.

NOTE The connecting rod cap fixing screws must always be replaced for permanent assembly.

Manually check that the connecting rods slide axially on the pins of the crankshaft.

Checking piston protrusion

Figure 59



After mounting the connecting rod – piston assemblies, check the protrusion of the pistons (2) at the T.D.C. in relation to the top surface of the crankcase with a dial gauge (1).

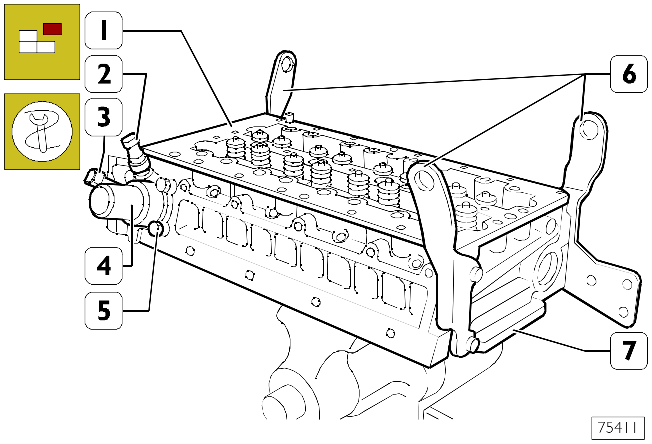
NOTE The difference between the minimum and maximum protrusions of the four pistons must be = 0.15 mm.

The cylinder head gasket in the set of spare gaskets needed for complete engine overhaul is supplied with a single thickness. Clearly, it is supplied separately too.

CYLINDER HEAD

Disassembly

Figure 60



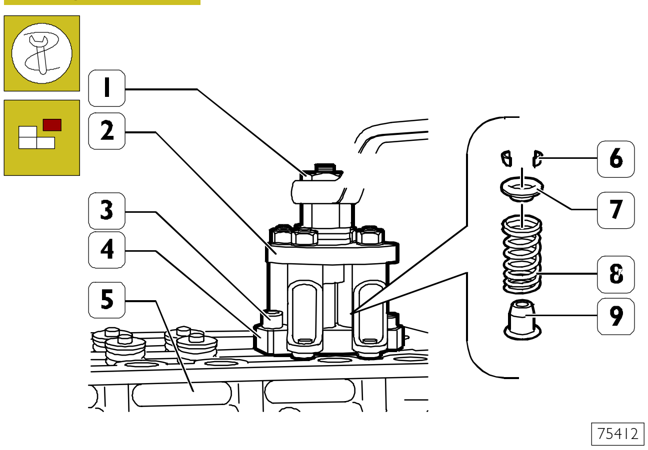
Place the cylinder head (1) on the mounting SP.2271 (7). Remove the brackets (6) for lifting the engine.

Use the wrench SP 2262 to remove the timing sensors (2 and 3).

Take out the screws (5) and remove the thermostat casing (4).

Removing valves

Figure 61



Fit part (4) of tool 99360260 onto the cylinder head (5) and secure it with the screws (3).

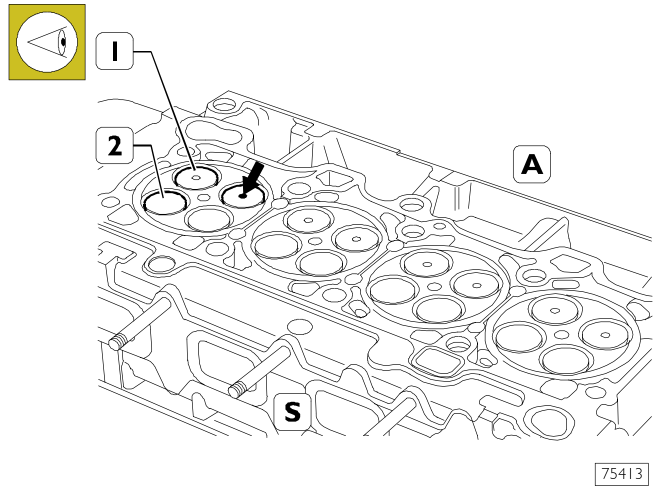
Fit part (2) of tool 99360260 onto part (4), screw down the nut (1) so that on compressing the springs (8) it is possible to remove the cotters (6). Then take out the plates (7) and the springs (8).

Using suitable pliers, remove the oil seal (9).

Repeat these operations on the remaining valves.

Turn the cylinder head over.

Figure 62



The intake (1) and exhaust (2) valves have the same diameter mushroom.

The central cavity (→) of the mushroom of the intake valve (1) is distinguished from that of the exhaust valve (2).

NOTE Before dismounting the valves from cylinder head, number them, to the purpose of being able to remount them in the position that was found on dismounting operation where they should not be replaced.

A = intake side – S = exhaust side

Remove the intake (1) and exhaust (2) valves.

Checking cylinder head seal

Check the hydraulic seal using a suitable tool.
Pump in water heated to approx. 90°C at a pressure of 2 ÷ 3 bars.

Replace the cup plugs if they are found to leak at oil, using a suitable drift for their removal – assembly.

NOTE Before mounting the plugs, apply LOCTITE 270 water-reacting sealant on their sealing surfaces.

If there is any leakage from the cylinder head, it must be replaced.

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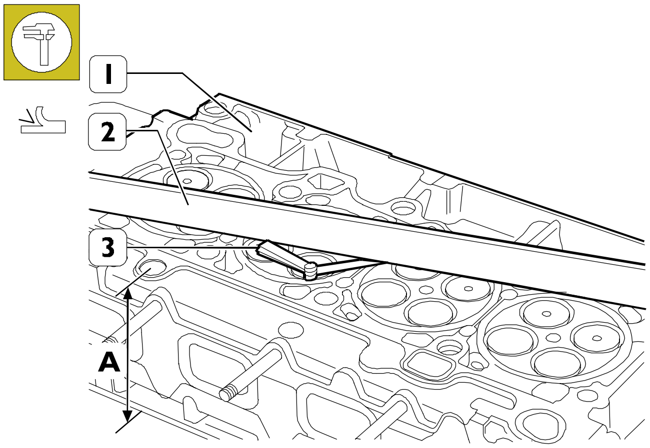
Checking cylinder head mating surface

Figure 63



75451

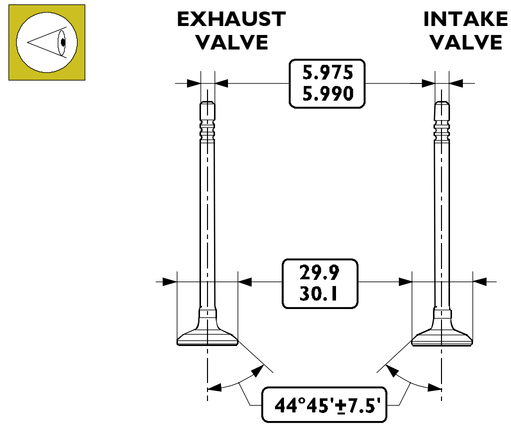
The mating surface of the head (1) with the cylinder block is checked using a rule (2) and a feeler gauge (3).
The deformation found on the entire length of the cylinder head must be no greater than 0.20 mm.
For greater values, regrind the cylinder head according to the values and instructions given in the following figure.

The nominal thickness A of the cylinder head is 112 ±0.1 mm; the maximum permissible removal of metal must not exceed a thickness of 0.2 mm.

NOTE After regrinding, check the valve recessing and if necessary regrind the valve seats to make the prescribed valve recessing.

VALVES

Figure 64

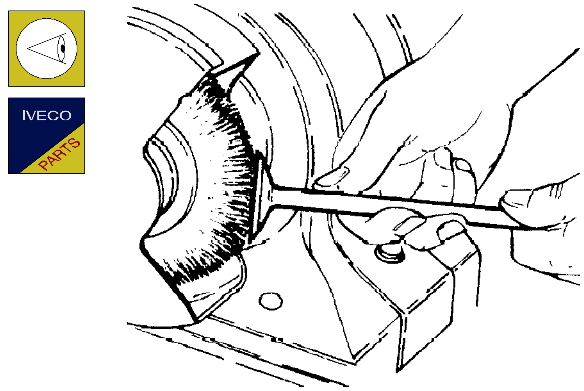


75452

MAIN DATA OF INTAKE AND EXHAUST VALVES

Removing deposits, refacing and checking valves

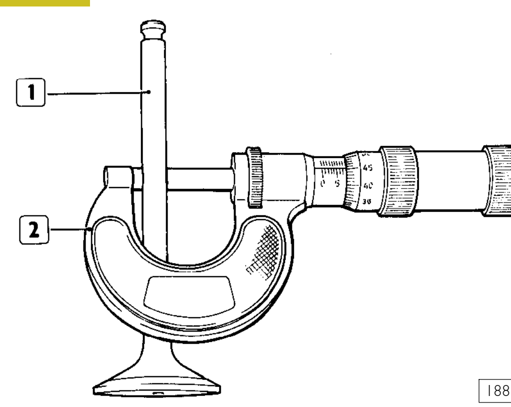
Figure 65



18625

Remove the carbon deposits on the valves with a wire brush.
Check that the valves show no signs of seizure, cracking or burning.

Figure 66

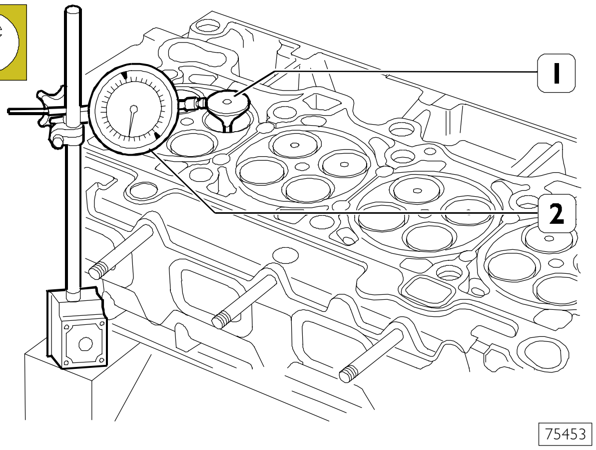


18882

Using a micrometer (2), measure the stem of the valves (1): it must be 5.975 – 5.990 mm. If necessary, regrind the seats on the valves with a grinding machine 99305018, removing as little material as possible.

Checking clearance between valve stem and valve guide and centring valves

Figure 67

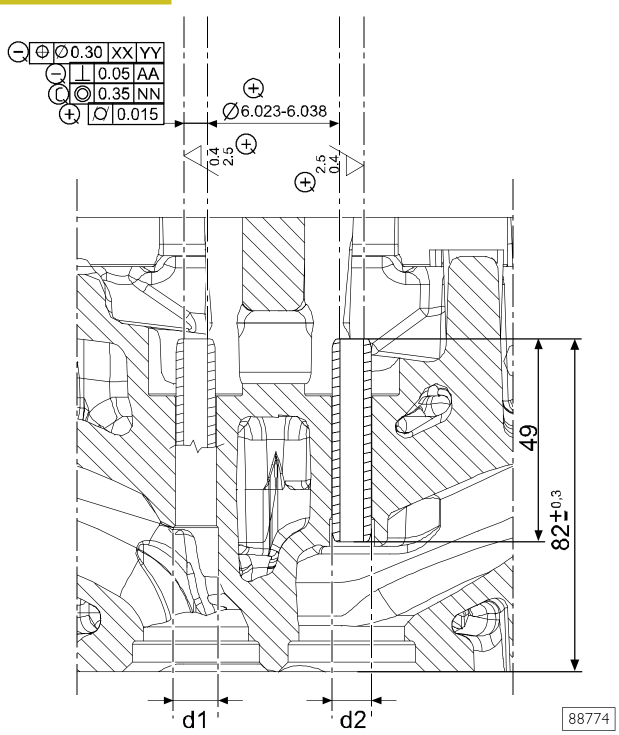


The checks are made using a dial gauge (2) with a magnetic base, positioned as illustrated. The assembly clearance is 0.033 – 0.063 mm.
Making the valve (1) turn, check that the centring error is no greater than 0.03 mm.

VALVE GUIDES

Replacing valve guides

Figure 68

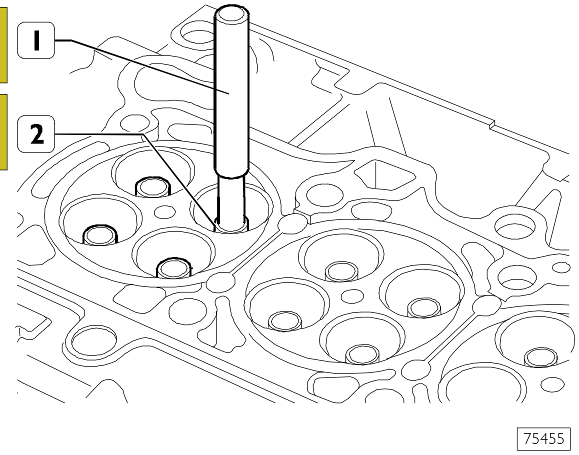


MAIN DATA OF VALVE GUIDES – SEATS

Valve guide seat inside Ø 9.980 ÷ 10.000 mm
Valve guide outside Ø 10.028 ÷ 10.039 mm

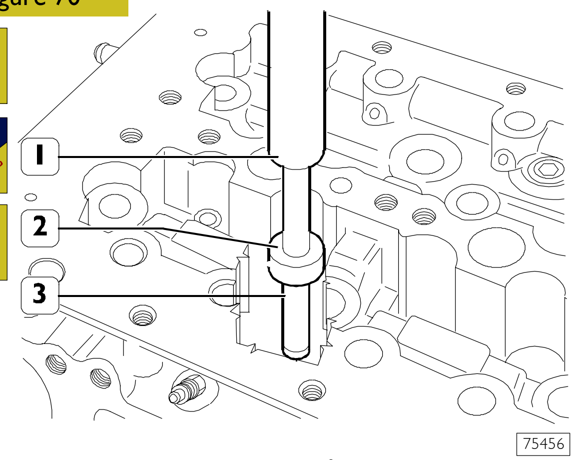
* Measurement to be made after driving in the valve guides.

Figure 69



Remove the valve guides (2) with the drift SP.2312 (1).

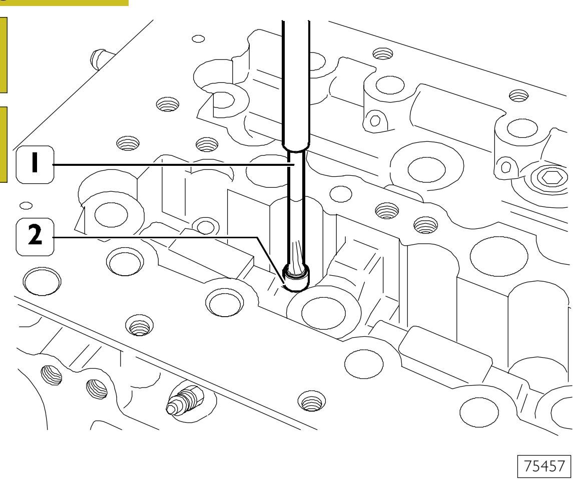
Figure 70



Heat the cylinder head to 80 – 100°C and, using the drift SP.2312 (1) provided with part SP.2311 (2), mount the new valve guides (3) previously chilled in liquid nitrogen.
Where above indicated tools are not available, mount valve guides positioning them in cylinder head according to dimension indicated in Figure 68.

Boring valve guides

Figure 71

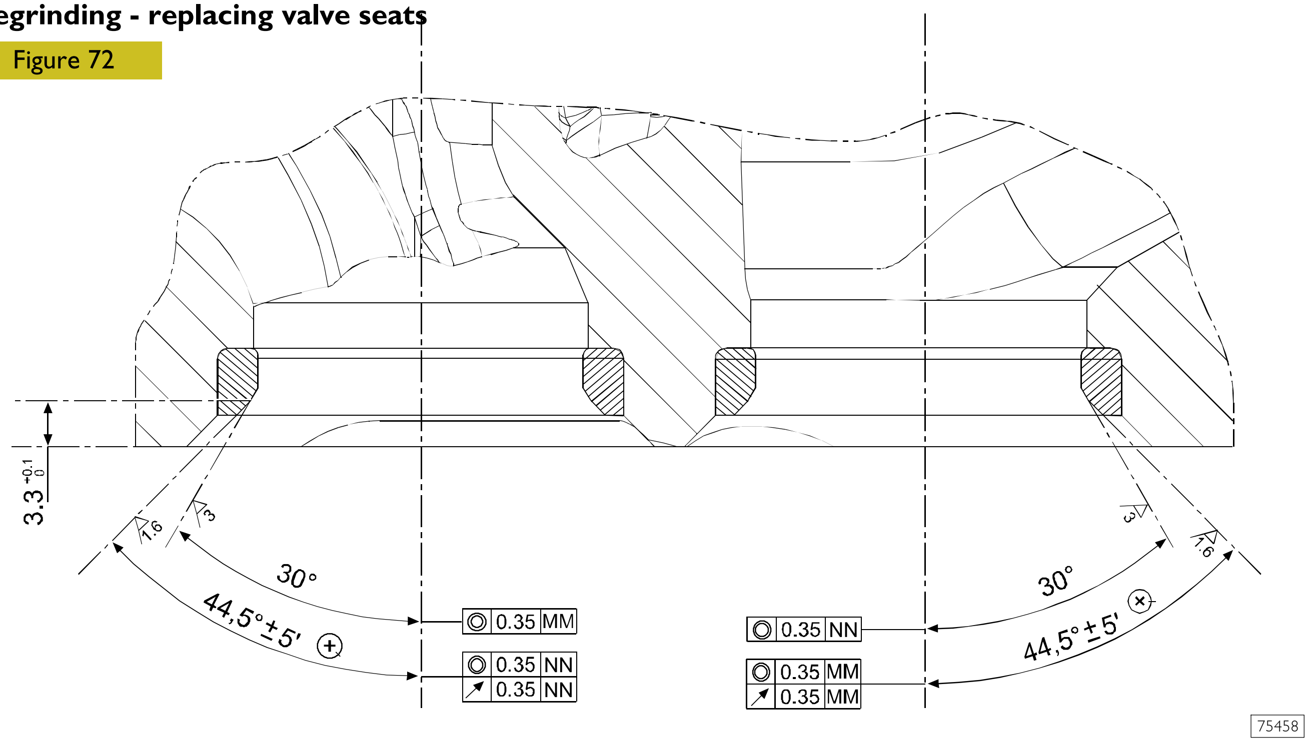


After driving in the valve guides (2), regrind them with the smoother SP.2310 (1).

VALVE SEATS

Regrinding - replacing valve seats

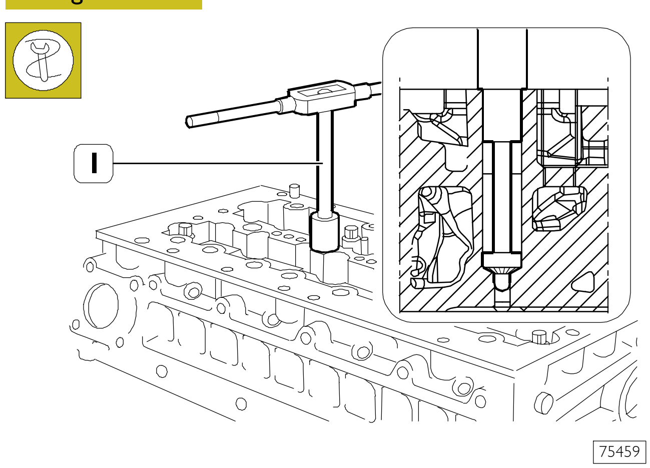
Figure 72



Check the valve seats. On finding any slight scoring or burns, regrind them with an appropriate tool according to the angles given in Figure 72.
Having to replace them, with the same tool and taking care not to affect the cylinder head, remove as much material from the valve seats as possible until, with a punch, it is possible to extract them from the cylinder head.

Heat the cylinder head to 80 ÷ 100°C and, using a suitable drift, fit in it the new valve seats, previously chilled in liquid nitrogen.
Using a specific tool, regrind the valve seats according to the angles given in Figure 72.

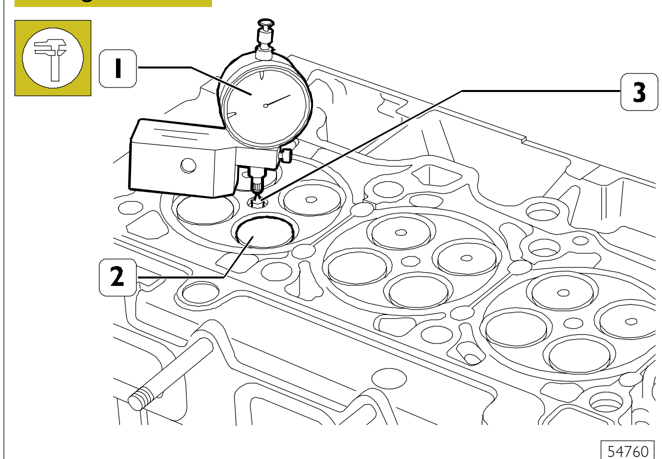
Figure 73



Using the milling cutter 99394038 (1), clean the injector seat of any deposits.

Mount the valves, block the seat of the electro-injectors and glow plugs; using a suitable tool, check the seal of the valves/seats.

Figure 74

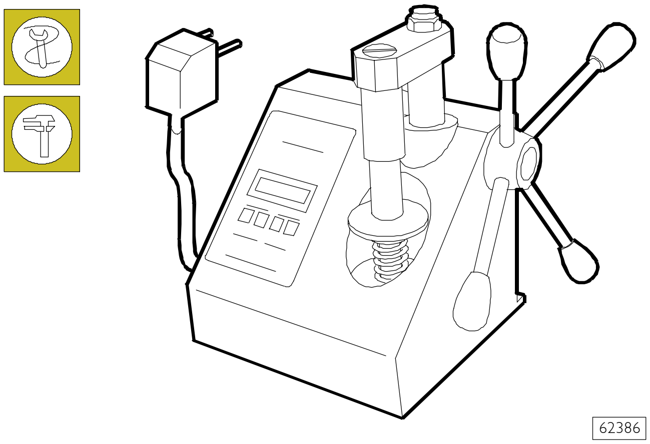


Using a dial gauge (1), check that, from the plane of the cylinder head, the valve recessing (2) and the protrusion of the injector (3) and of the glow plug have the prescribed value:

- Valve recessing: 0.5 ÷ 0.8 mm.
- Injector protrusion: 2.77 ÷ 3.23 mm.
- Glow plug protrusion: 3.78 mm.

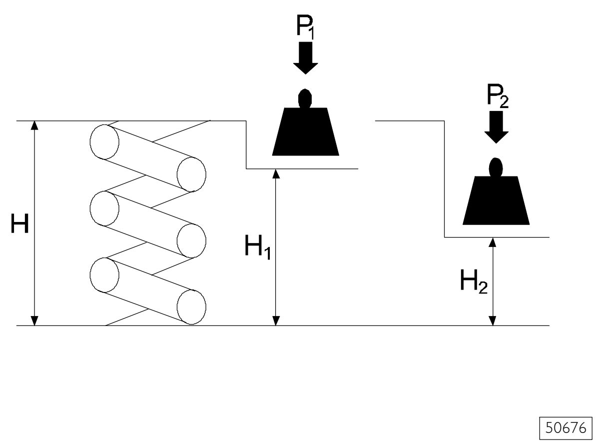
VALVE SPRINGS

Figure 75



Before assembly, check the flexibility of the valve springs with the tool 99305047. Compare the load and elastic deformation data with those of the new springs given in the following figures.

Figure 76

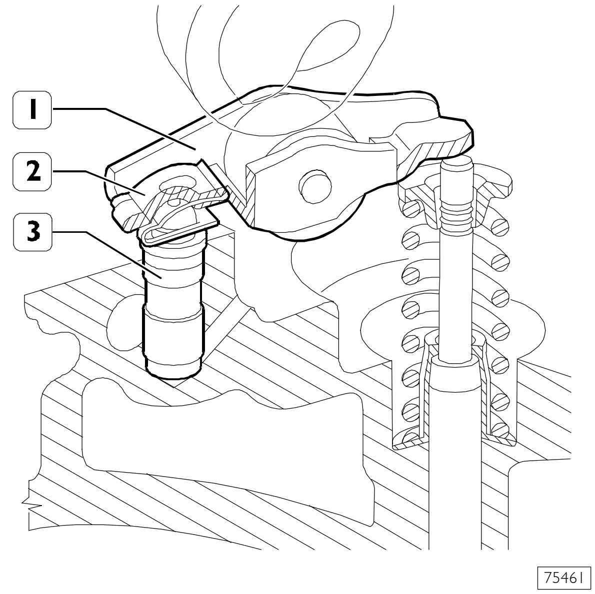


MAIN DATA TO CHECK INTAKE AND EXHAUST VALVE SPRINGS

Height	Under a load of
mm	kg
H 54	Free
H1 45	P 243 ±12
H2 35	P1 533 ±24

ROCKER ARMS – TAPPETS

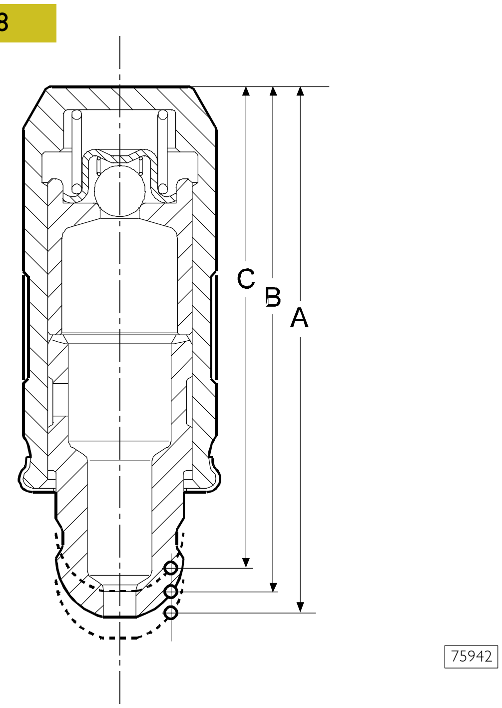
Figure 77



COMPLETE ROCKER ARM ASSEMBLY

The rocker arm assembly is composed of the rocker arm (1), hydraulic tappet (3), made integral with each other by the clip (2).

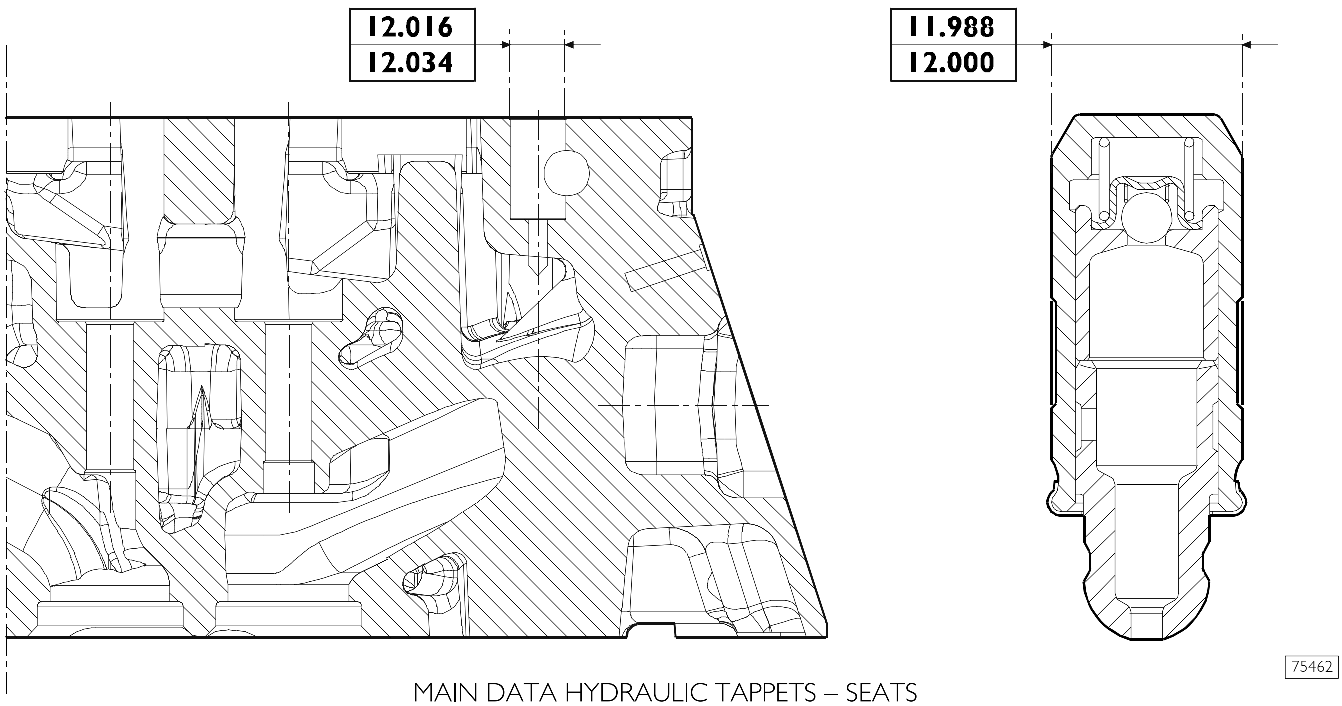
Figure 78



CROSS-SECTION OF THE HYDRAULIC TAPPET

A = 32.44 ±0.3, end of stroke
B = 31.30, working position
C = 29.75 ±0.25, start of stroke

Figure 79



MAIN DATA HYDRAULIC TAPPETS – SEATS

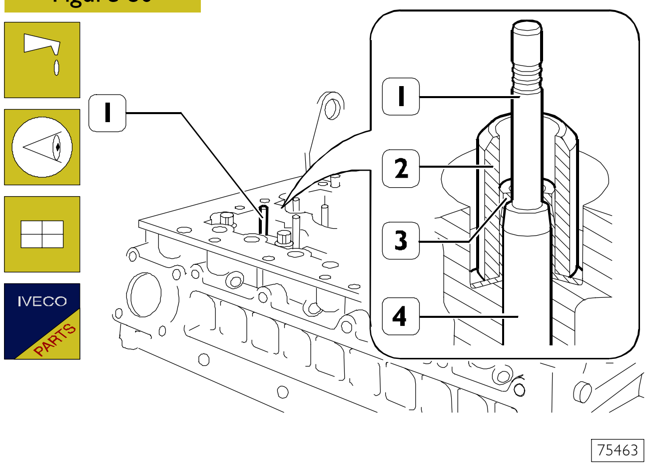
Checks

The sliding surface of the tappets must have no scoring/dents; replace them if they do.

Using a micrometer, measure the diameter of the tappets and, using a bore meter, measure the diameter of the seats in the cylinder head; the difference in the measurements will give the assembly clearance.

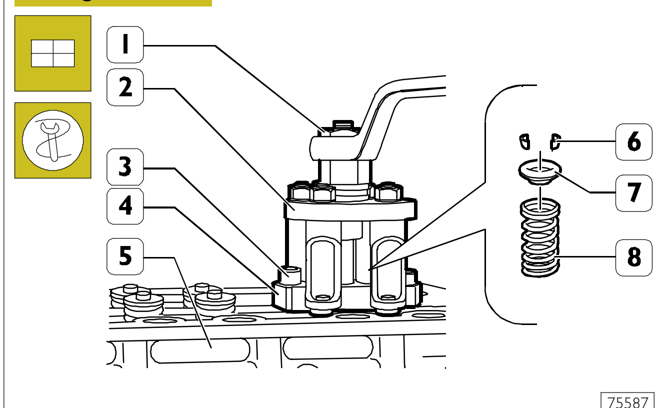
ASSEMBLING CYLINDER HEADS

Figure 80



Lubricate the stem of the valves (1) and insert them into the associated valve guides (4) according to the position marked during removal. Using tool SP.2264 (2), mount the oil seals (3) on the valve guides (4).

Figure 81



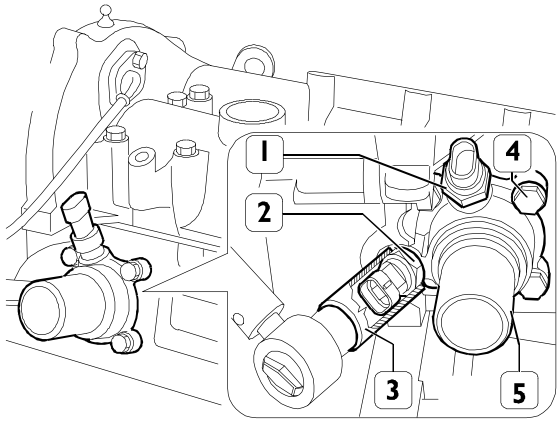
Position the springs (8) and plates (7) on the cylinder head (5).

Fit the part (4) of tool 99360260 onto the cylinder head (5) and secure it with the screws (3).

Fit the part (2) of tool 99360260 onto part (4), screw down the nut (1) so that by compressing the springs (8) it is possible to insert the retaining cotters (6); then unscrew the nut (1) checking that the cotters (6) have settled in correctly.

Repeat these operations on the remaining valves.

Figure 82



75464

Fit the thermostat casing (5) with a new seal and tighten the fixing screws (4) to the prescribed torque.

Mount temperature sensors (1 and 2), and tighten them at prescribed torque.

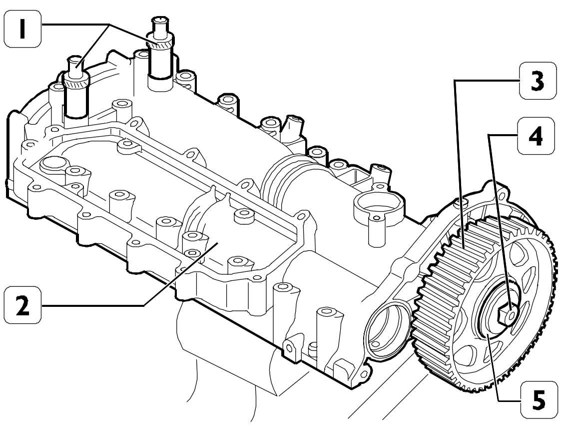
For tightening sensor (2), use wrench SP.2262 (3).

Mount the temperature sensors (1 and 2) and, using the wrench SP.2263 (3), tighten them to the prescribed torque.

Overhead

Overhead removal

Figure 83

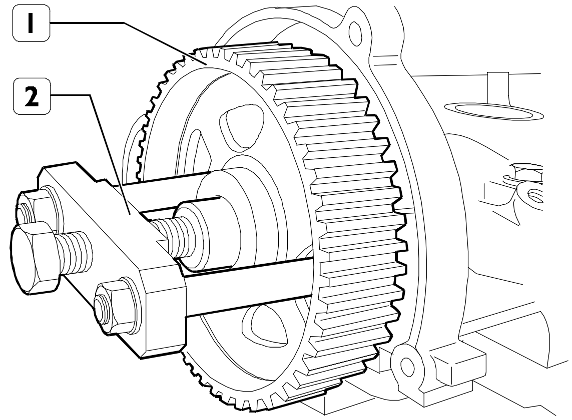


75465

Position the overhead (2) together with the pins 99360614 (1) on the mounting SP. 2271.

Take out the screw (4) with the washer (5) beneath fastening the toothed pulley (3).

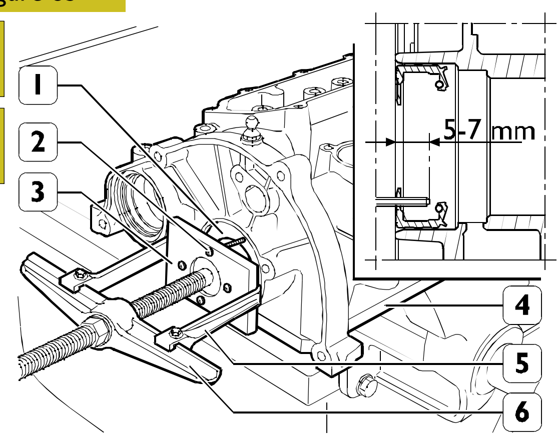
Figure 84



75466

Using the extractor 99340028 (2) extract the toothed pulley (1) driving the camshaft.

Figure 85

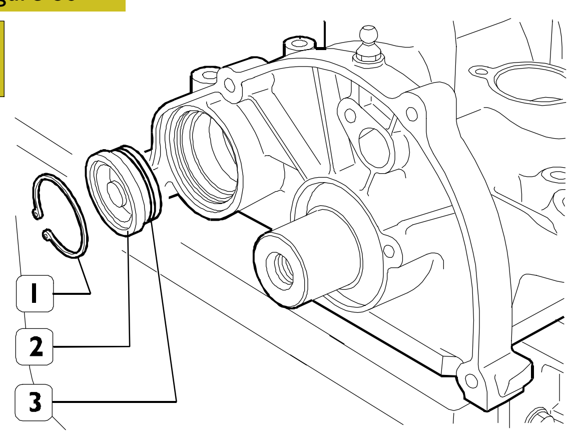


75467

Using four self-tapping screws (2), apply the tool SP. 2325 (3) to the seal (1) and with the extractor (5 and 6) remove the seal (1) from the overhead (4).

NOTE The screws (2) must be screwed down so they get positioned at the dimension shown in the figure.

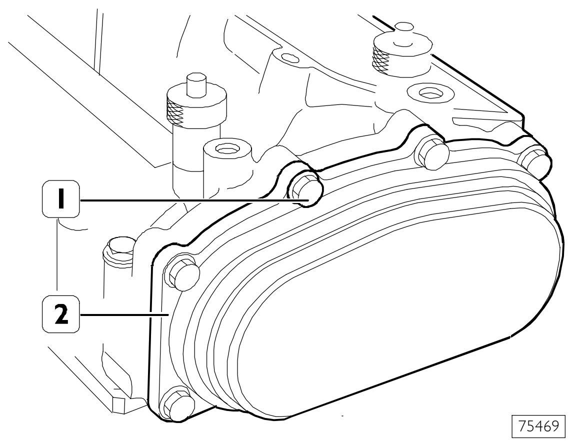
Figure 86



75468

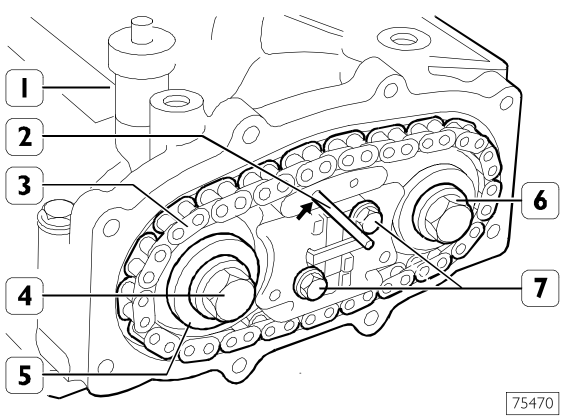
Remove the circlip (1) and take off the cover (2) together with the seal (3).

Figure 87



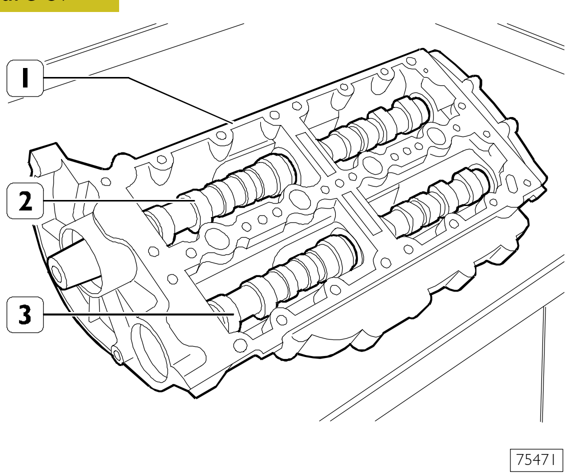
Take out the screws (1) and remove the rear cover (2) together with its gasket.

Figure 88



Insert a suitable pin (2) in the hole (⇒) of the chain drive (3). Take out the screws (4) and (6) with their washers (5) for fixing gears to the camshafts.
Take out the screws (7) and remove the chain drive (3) from the overhead (1).

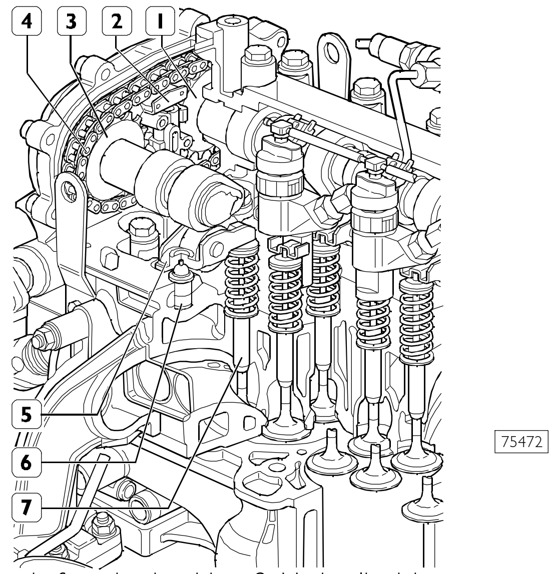
Figure 89



Turn over the overhead (1) and, taking care not to damage the seats, extract the camshafts (2) and (3) from it.

TIMING SYSTEM

Figure 90

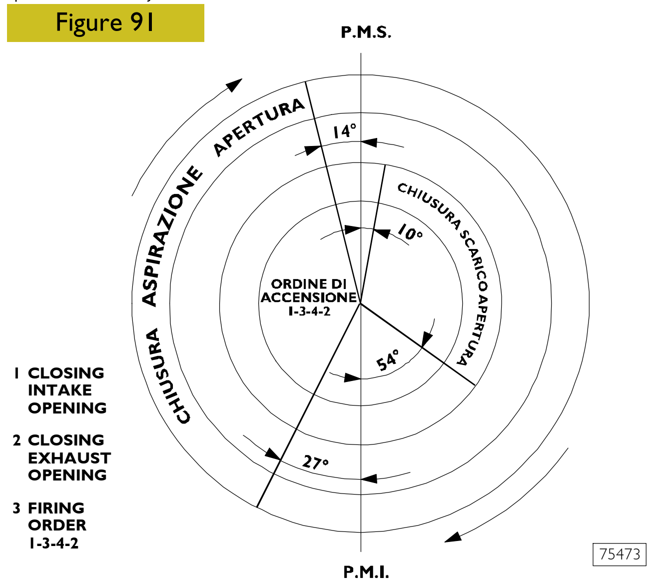


1. Camshaft on intake side – 2. Hydraulic tightener – 3. Camshaft on exhaust side – 4. MORSE chain – 5. Rocker arms – 6. Hydraulic reacting tappet – 7. Valve assembly.

Description

The timing system is the type with a twin camshaft in the head and four valves per cylinder with hydraulic tappets.
Motion is transmitted by the crankshaft, via a toothed belt, to the gear keyed onto the intake valve drive shaft. The drive transmission of the exhaust valve drive shaft takes place via a MORSE-type chain kept under tension by a hydraulic tightener.
The toothed belt, moreover, drives the water pump and the high-pressure pump CP3 and is kept at the right tension by an automatic tightener roller.
The four valves move by the action of the "free" rocker arms (with no supporting shaft).
The rocker arms, one per valve, are always in contact with the corresponding cam and are kept in this position by a hydraulic reacting tappet, thereby eliminating the need for periodical adjustment.

Figure 91



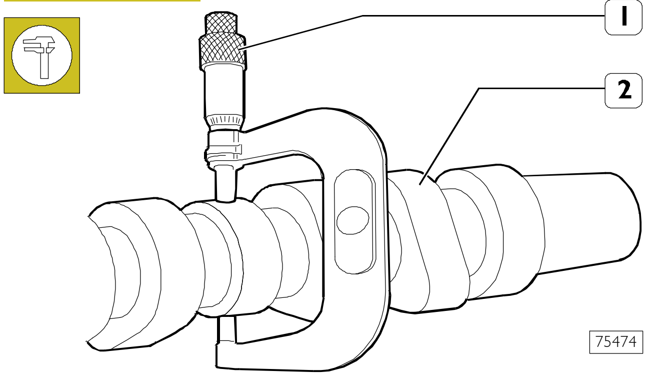
TIMING SYSTEM DIAGRAM

Camshaft

Checks

The surfaces of the shaft supporting pins and of the cams must be finely honed; if there is any sign of meshing or scoring, replace the shaft.

Figure 92



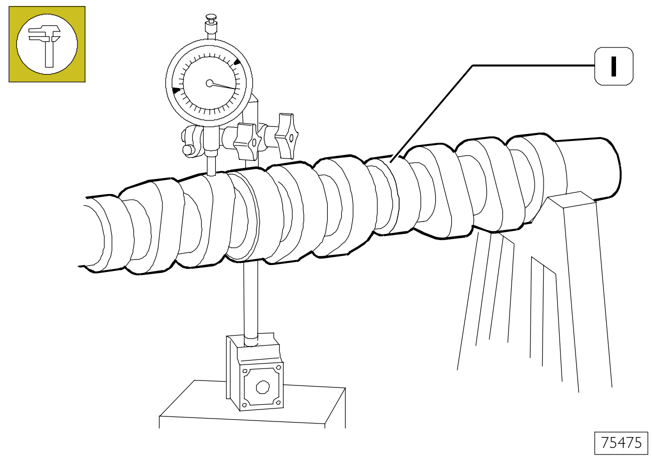
Using a micrometer (1), measure the diameter of the pins (2) of the camshaft and, using a bore meter, measure the diameter of the supporting seats in the overhead.

The difference between these two measurements gives the existing clearance.

The nominal assembly clearance is 0.037 ÷ 0.088 mm.

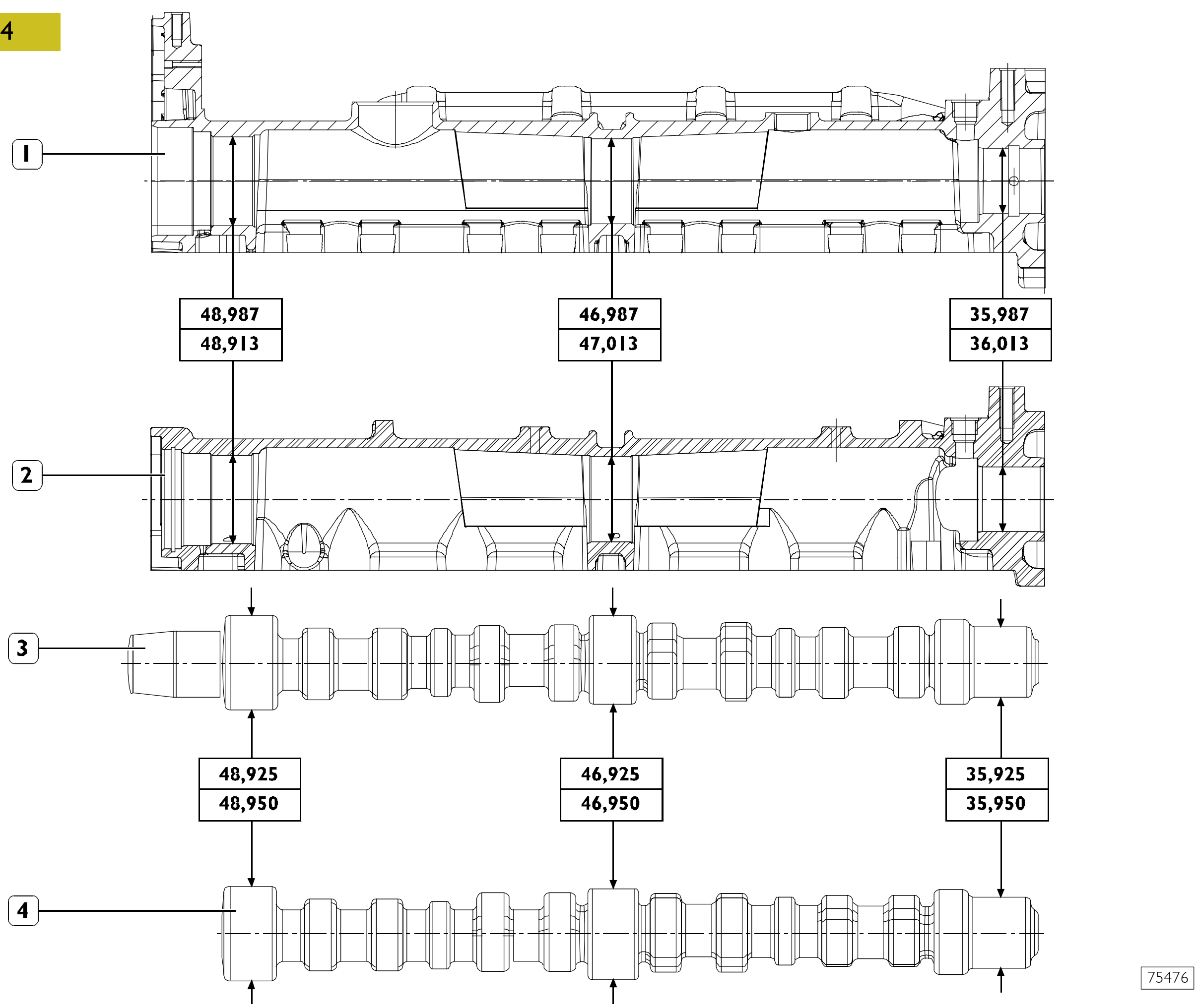
Checking cam lift and pin alignment

Figure 93



Set the shaft (1) on tailstocks and, using a dial gauge on the middle mounting, check that the alignment error is no greater than 0.04 mm; replace the shaft if it is. In addition, check the cam lift: it must be as prescribed; replace the shaft if it is any different.

Figure 94



MAIN DATA, CAMSHAFT PINS AND SEATS

1. Intake valve camshaft seats – 2. Exhaust valve camshaft seats – 3. Intake valve camshaft – 4. Exhaust valve camshaft.

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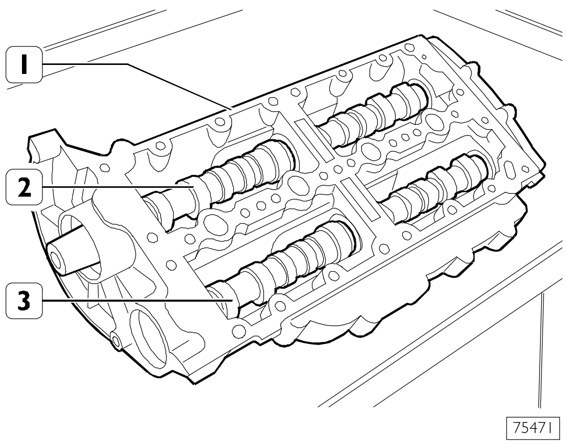
Assembling overhead

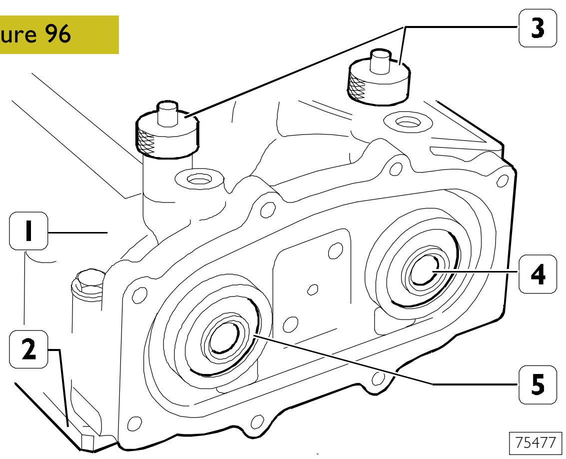
Figure 95



Lubricate the supporting pins of the shafts (2 and 3) and fit them in the overhead (1).

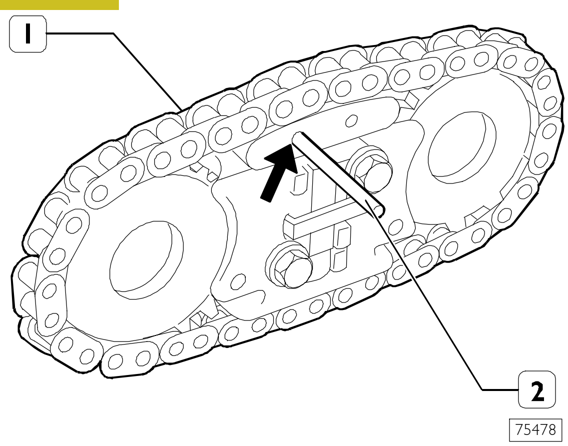
NOTE In this operation, take care not to damage the overhead supporting seats.

Figure 96



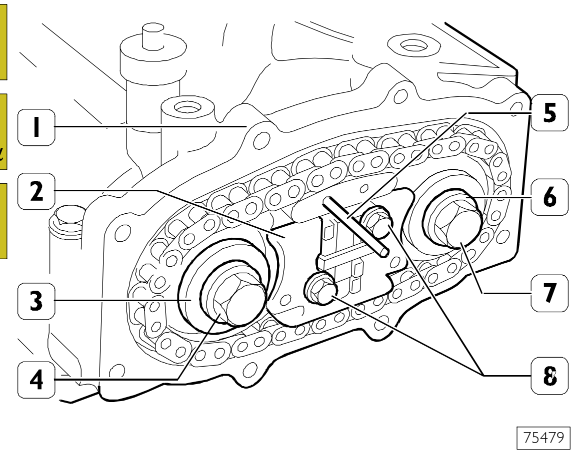
Position the overhead (1) and secure it on the mounting SP.2271 (2).
Position the camshafts (4 and 5) so as to be able to insert the pins 99360614 (3) into their radial holes through the threaded holes of the overhead.

Figure 97



Compress the tightener so as to be able to insert a suitable pin (2) into the hole (→) of the chain drive (1).

Figure 98



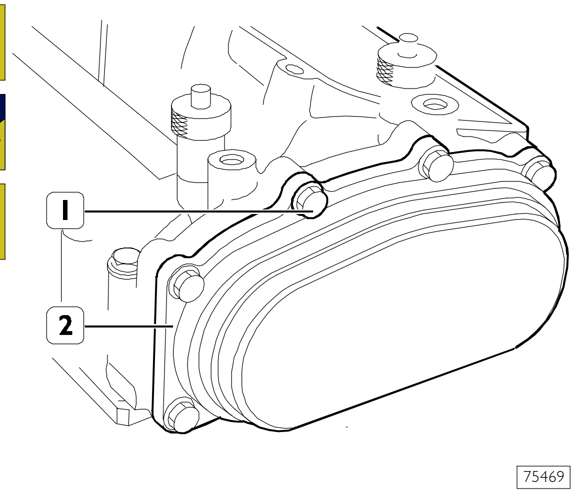
Fit the chain drive (2) on the camshafts and secure it to the overhead (1) tightening the screws (8) to the prescribed torque.

Screw down the screws (4) and (7) with the washers (5) and (6) and tighten them as follows:

- ❑ Tighten the screw (7) to a torque of 50 Nm.
- ❑ Close further with an angle of 60°.
- ❑ Take out the pin (5).
- ❑ Tighten the screw (4) to a torque of 50 Nm.
- ❑ Close further with an angle of 60°.

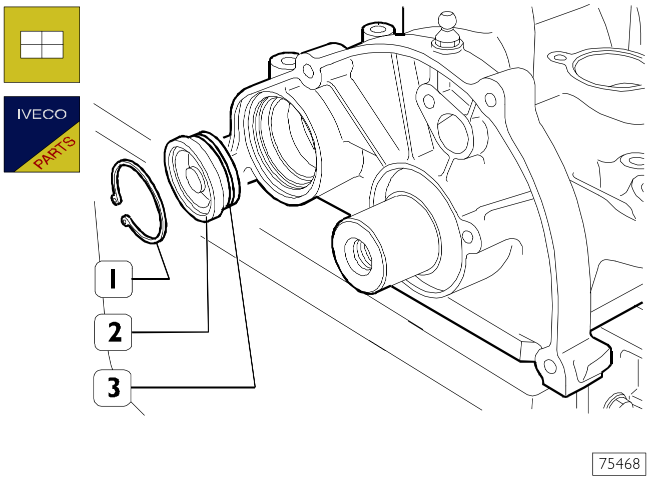
NOTE Use the goniometer 99395216 for the angle closing.

Figure 99



Fit on the rear cover (2) with a new gasket and tighten the fixing screws (1) to the prescribed torque.

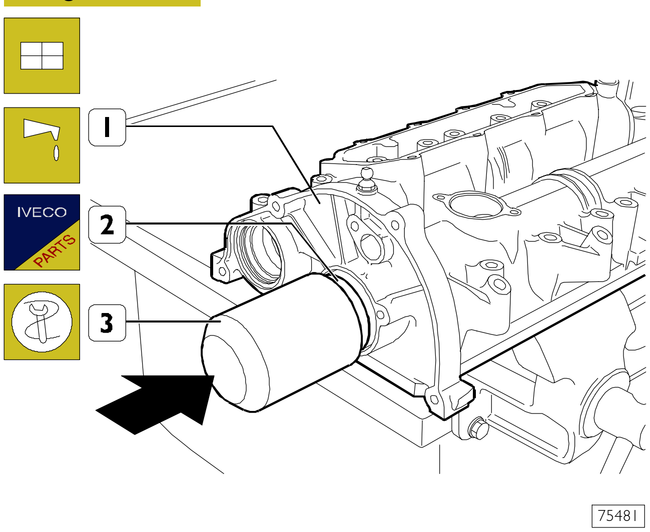
Figure 100



Fit a new seal (3) on the cover (2) and fit this in the overhead.

Fit on the seal (1).

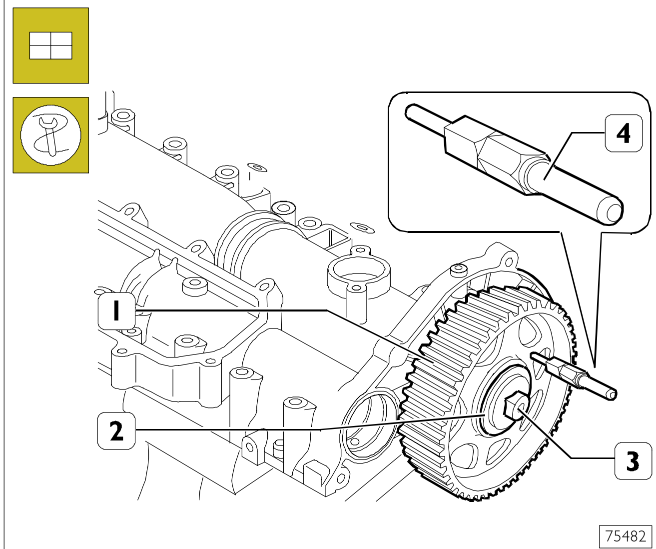
Figure 101



Lubricate the shank of the camshaft.

Using the keying device 99374458 (3), fit the seal (2) in the overhead (1).

Figure 102



Fit the toothed pulley (1) onto the camshaft so as to align the hole of the pulley with that of the overhead and insert the tool 99360608 (4) into these holes. Screw down the screw (3) together with the washer (2) without tightening fully.

NOTE The toothed pulley (1, Figure 102) is not locked on the shaft since it must be able to turn when fitting and tensioning the timing belt. For the same reason, keep the tools 99360608 (4, Figure 102) and 99360614 (3, Figure 96) fitted.

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TIGHTENING TORQUE

PART	TORQUE	
	Nm	kgm
Cylinder head central fixing screw		
first phase: pre-tightening	100	9.8
second phase: angle	90°	
third phase: angle	90°	
Cylinder head side fixing screw		
first phase: pre-tightening	50	4.9
second phase: angle	60°	
third phase: angle	60°	
Hex screw with flange M8x1.25 L 40 fixing overhead	25	2.5
Hex screw with flange M8x1.25 L 77 fixing overhead	25	2.5
Central base fastening screw		
first phase: pre-tightening	50 ± 5	5 ± 0.5
second phase: angle	60° ± 2.5°	
third phase: angle	60° ± 2.5°	
Outer base fastening screw	36 ÷ 30	3.6 ÷ 3
Connecting rod cap fixing screw		
first phase: pre-tightening	40	4
second phase: angle	60°	
Hex screw with flange M12x1.25 L 43 fixing engine flywheel		
first phase: pre-tightening	30	3
second phase: angle	90°	
Cylindrical socket head screw fixing phonic wheel to crankshaft •	15	1.5
Nozzle union	25	2.5
Tapered threaded socket plug R 3/8" x 10 oil circuit	22	2.2
Water drain plug M14x1.50 L 10	25	2.5
Union on crankcase for oil return from turbocharger R 3/8"	50	5
Screw M6x1 fixing suction strainer	10	1
Male threaded socket plug M28x1.5 L11 fixing	100	9.8
Hex screw with flange M8x1.5 L 35 fixing frame retaining oil sump	25	2.5
Hex screw with flange M6x1 L30 fixing frame retaining oil sump	10	1
Hex screw with flange M6x1 L25 fixing frame retaining oil sump	10	1
Tapered threaded socket plug M6x1x8.5*	2	0.2
Male threaded plug with O-ring M22x1.5 L16	50 ±10	5 ±1
Hex screw with flange M6x1 L20 fixing oil vacuum pump assembly	10	1
Hex screw with flange M6x1 L50 fixing oil vacuum pump assembly	10	1
Oil filter cartridge M22x1.5 L7	25	2.5
Union fixing heat exchanger M22x1.5	80 ±5	7.8 ±0.5
Hex screw with flange M12x1.25 L55 fixing toothed pulley controlling timing system	90	8.8
Hex screw with flange M18x1.5 L78 fixing pulley on crankshaft	300	30
Hex screw with flange M8x1.25 L45 fixing pulley on damper	30	3
Hex screw with flange M8x1.25 L60 fixing automatic tightener	36	3.6
High pressure pump gear fastening hex nut with flange M14x1.5	70	6.9
Fastener for complete guide pulley roller for timing belt M8x1.25 L45	25	2.5

• Thread pre-treated with Loctite.
* Apply Loctite on the thread.

PART	TORQUE	
	Nm	kgm
Tapered threaded socket plug R 3/8" x 10	17	1.7
Tapered threaded socket plug R 1/8" x 8	7	0.7
Tapered threaded socket plug R 1/4" x 9	9	0.9
Hex screw with flange M12x1.25 L65 fixing gear for camshaft chain	115	11.3
Hex screw with flange M6x1 L25 fixing chain cover	10	1
Hex screw with flange M6x1 L35 automatic tightener	10	1
Threaded plug M14x1.5 L10	25	2.5
Ball joint fastening screw M6x1x9	10	1
Hex screw with split washer and flat washer fixing water pump M8x1.25 L28	25	2.5
Hex screw with split washer and flat washer fixing water pump M6x1 L20	10	1
Flanged screw M8x1.25 fixing water outlet union	25	2.5
Flanged screw M8x1.25 fixing piezometric tube on intake manifold	25	2.5
Flanged nut M8x1.25 fixing piezometric tube on bracket	18	1.8
Self-tapping screw L16 fixing bracket on coalescence filter cover	6	0.6
Flanged screw M6x1x16 fixing piezometric tube	10	1
Self-tapping flanged screw L14 fixing piezometric tube on front cover	2	0.2
Coupling M10x1x10 fixing vapour outlet	12	1.2
Union M10x1x19 fixing vapour outlet	14 ÷ 16	1.4 ÷ 1.6
Hex screw with flange M8x1.25 L25 fixing thermostat	25	2.5
Hex screw with flange M8x1.25 L100 fixing air-conditioner compressor	25	2.5
Hex screw with flange M8x1.25 L120 fixing air-conditioner compressor	25	2.5
Hex screw with flange M8x1.25 L50 fixing air-conditioner compressor mounting	25	2.5
Cylindrical socket head screw M8x1.25x40 fixing air-conditioner compressor drive belt guide pulley	25	2.5
Hex screw fixing bottom of alternator M10x1.25 L40 and M10x1.5 L50	50	5
Hex nut with flange fixing top of alternator M10x1.25 L10	-	-
Fastener for complete guide pulley roller for timing belt M10x1.25 L50	40	4
Allen head screw fixing automatic tightener M8x1.25 L65	25	2.5
Hex screw with flange M8x1.25 L45 fixing pulley on damper	30	3
Screw plug with washer M12x1.5 L20	30	3
Vacuum pump coupling M10x1 on oil vacuum pump assembly	10	1
Flanged screw M6x1x27 fixing timing cover	7.5	0.7
Hex screw with flange M6x1 L27 fixing coalescence filter assembly	10	1
Screw M6x1 L12 fixing sump blow-by oil drain pipes	10	1
Union M20x1.5 blow-by breather socket	30	3
Hex screw with flange M8x1.25 L90 fixing intake manifold	30	3
Flanged nut M8x1.25 fixing exhaust manifold	25	2.5
Flanged screw M6x1 fixing oil fillpipe	10	1
Flanged screw M8x1.25 fixing oil dipstick pipe	18	1.8
Glow plug M8x1 L11.5	8 ÷ 11	0.8 ÷ 1.1
High-pressure injection system		
Hex screw fixing hydraulic accumulator M8x1.25 L50	28	2.8
Screw M8x1.25 L30 fixing high-pressure pump	25	2.5
Screw M8x1.25 fixing bracket anchoring fuel delivery pipe	25	2.5
Fitting for fuel pipe M14x1.50 (forged hydraulic accumulator)	25 ± 2	2.5 ± 0.2
Fitting for fuel pipe M12x1.50 (forged hydraulic accumulator)	25 ± 2	2.5 ± 0.2
Hex screw fixing electro-injector retaining bracket	28	2.8
Hex screw with flange fixing low-pressure fuel pipes M6x1 L30	10	1

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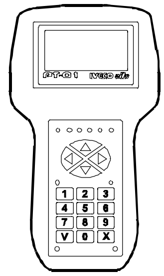
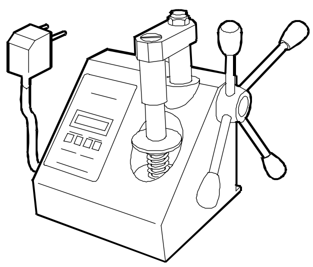
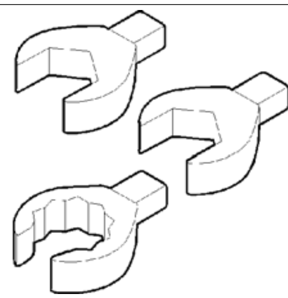
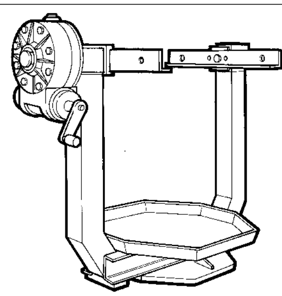
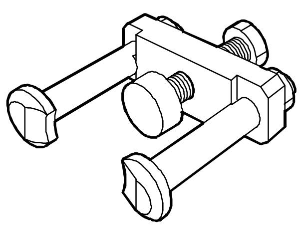
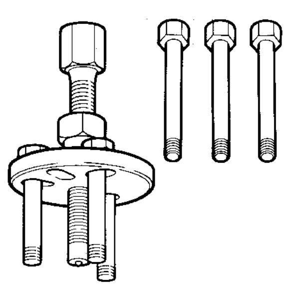
PART	TORQUE	
	Nm	kgm
Pipe fitting M12x1.5 to secure electric injectors side and high pressure pump side piping (welded hydraulic accumulator)	25 ± 2	2.5 ± 0.2
Pipe fitting M14x1.5 to secure hydraulic accumulator side piping (welded hydraulic accumulator)	19 ± 0.2	1.9 ± 0.2
Union M12x1.5 L23 - L24 and M12x1.5 Ll2 for fixing fuel pipes	25	2.5
Fitting for fastening multiple filler to high pressure pump M12x1.5 L24	25	2.5
Flanged screw M12x1.5 fixing water temperature sensor	30	3
Flanged screw M6x1 fixing air temperature sensor	10	1
Flanged screw M6x1 fixing engine speed sensor	10	1
Socket-head screw M6x1 fixing timing sensor	10	1
Screw M8x1.25 fixing air duct bracket	28	2.8
Screw M8x1.25 fixing air duct	25	2.5
Cylindrical socket-head screw M6x1 for V-clamp	8	0.8
Nut M8x1.25 fixing turbocharger	25	2.5
Flanged screw M8x1.25 fixing turbocharger outlet pipe	25	2.5
Fitting M14x1.5 or M12x1.5 for pipe delivering oil to turbocharger	35	3.5
Fitting M22x1.5 for oil return pipe from turbocharger	45	4.5
Flanged screw fixing oil return pipe from turbocharger	10	1
Hex screw with flange M8x1.25 L40 fixing power steering pump	25	2.5
Hex screw with flange M12x1.25 L155 fixing electromagnetic coupling mounting	90	8.8
Hex screw with flange M8x1.25 L20 fixing manoeuvring hooks	25	2.5
Flanged screws M10x1.25 fixing engine mounts	50	5
Oil level sensor M12x1.25	25	2.5
Thermometric switch/transmitter M16x1.5	25	2.5
Oil pressure switch M14x1.5	40	4
Cylindrical socket-head screw M8x1.25 fixing E.G.R. valve	25	2.5
Flanged screw M8x1.25 fixing E.G.R. heat exchanger	25	2.5
Flanged nut M8x1.25 fixing elbow	25	2.5
Compensator fastening nut M8x1.25	25	2.5
Oil pressure regulation valve cap	100	10

SECTION 5

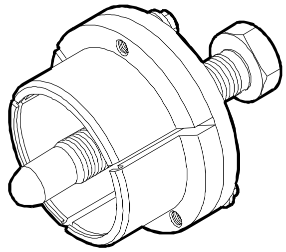
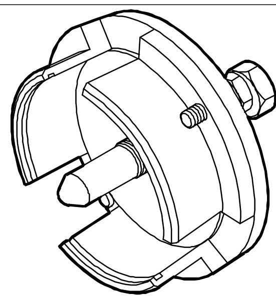
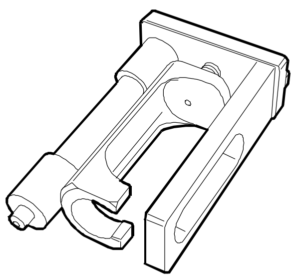
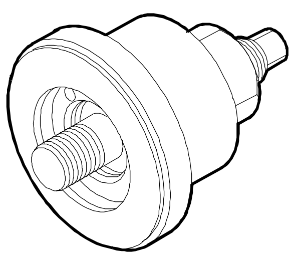
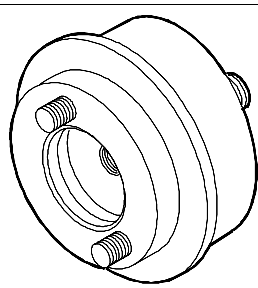
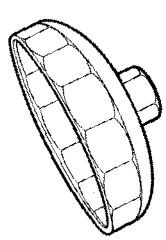
Tools

Page

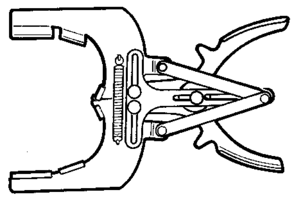
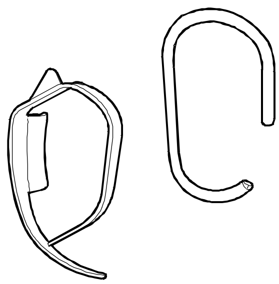
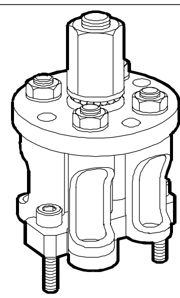
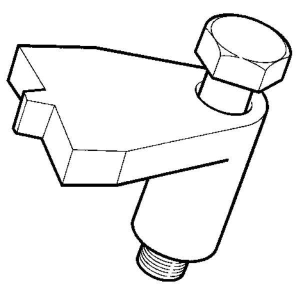
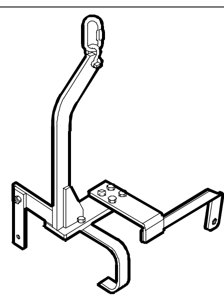
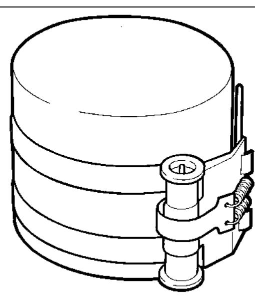
TOOLS

TOOL NO.		DESCRIPTION
8093731		Tester PT01
99305047		Appliance to check spring loads
99317915		Set of six box-type wrenches (14-17-19 mm)
99322205		Rotary telescopic stand for overhauling assemblies (capacity 700 daN, torque 120 daN/m)
99340028		Extractor for camshaft pulley
99340035		High-pressure pump toothed pulley extractor

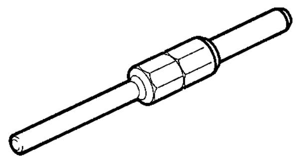
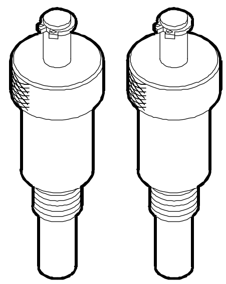
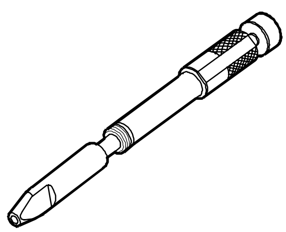
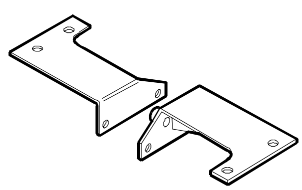
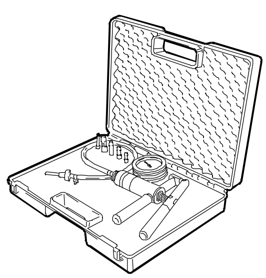
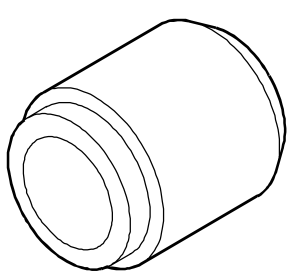
TOOLS

TOOL NO.		DESCRIPTION
99340057		Tool to remove crankshaft front gasket
99340058		Tool to remove crankshaft rear gasket
99342153		Tool to extract injectors
99346254		Keying device for mounting crankshaft front gasket
99346255		Keying device for mounting crankshaft rear gasket
99360076		Tool to remove cartridge filters

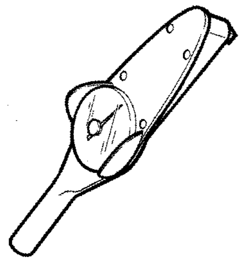
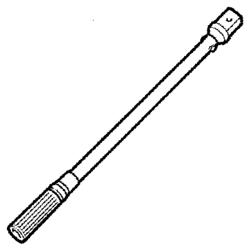
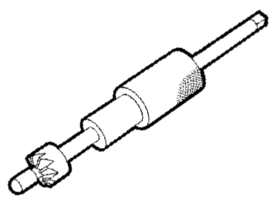
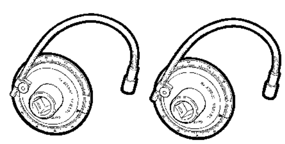
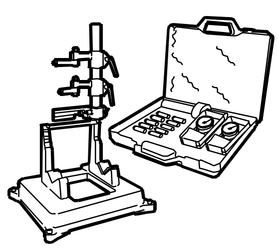
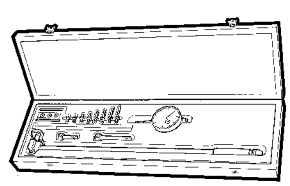
TOOLS

TOOL NO.		DESCRIPTION
99360183		Pliers for mounting rings on engine pistons
99360191		Guide for flexible belt
99360260		Tool for removing and refitting engine valves
99360306		Tool to retain engine flywheel
99360544		Arm for removing and refitting engine
99360605		Band to insert standard and oversized pistons into the cylinders

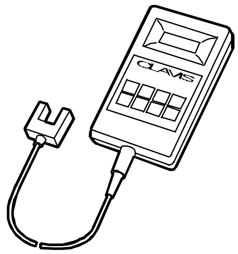
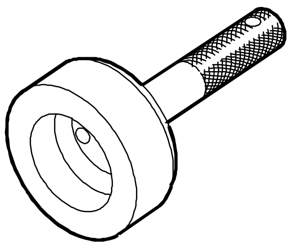
TOOLS

TOOL NO.		DESCRIPTION
99360608		Tool for positioning timing gear
99360614		Tool (2) for camshaft timing
99360615		Tool for crankshaft timing
99361038		Brackets securing engine to rotary stand 99322205
99367121		Manual pump to measure pressure and vacuum
99374458		Keying device for mounting oil seal gasket on camshaft front cover

TOOLS

TOOL NO.		DESCRIPTION
99389819		Torque wrench (0-10 Nm) with square 1/4" connection
99389829		9x12 coupling torque wrench (5-60 Nm)
99394038		Milling cutter to regrind injector seat
99395216		Pair of meters for angular tightening with square 1/2" and 3/4" connection
99395363		Complete square to check for connecting rod distortion
99395687		Bore meter (50 – 178 mm)

TOOLS

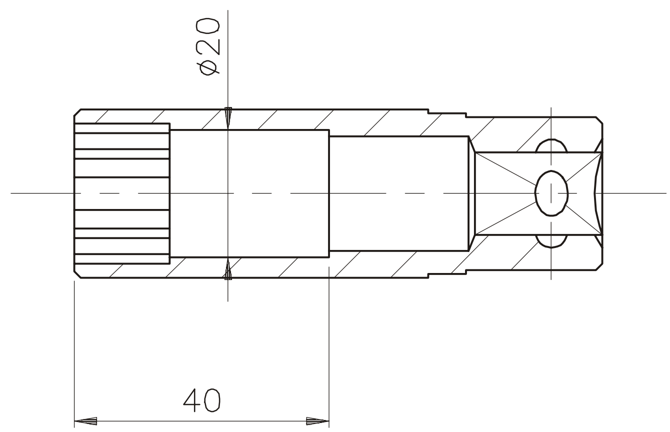
TOOL NO.		DESCRIPTION
99395849		Device for checking belt tension (frequency from 10.0 to 600 Hz)
99396037		Centring ring for crankshaft front gasket cover

EXPERIMENTAL TOOLS

This section shows the working drawings for the experimental tools (S.P.) used in overhauling the engine described in this section, which may be made by the repair shops.

VARIA DA ART. COMMERCIALE USAG cod.235L 1/2" – Ch.19

SOLO PER QUANTO INDICATO



Modification:

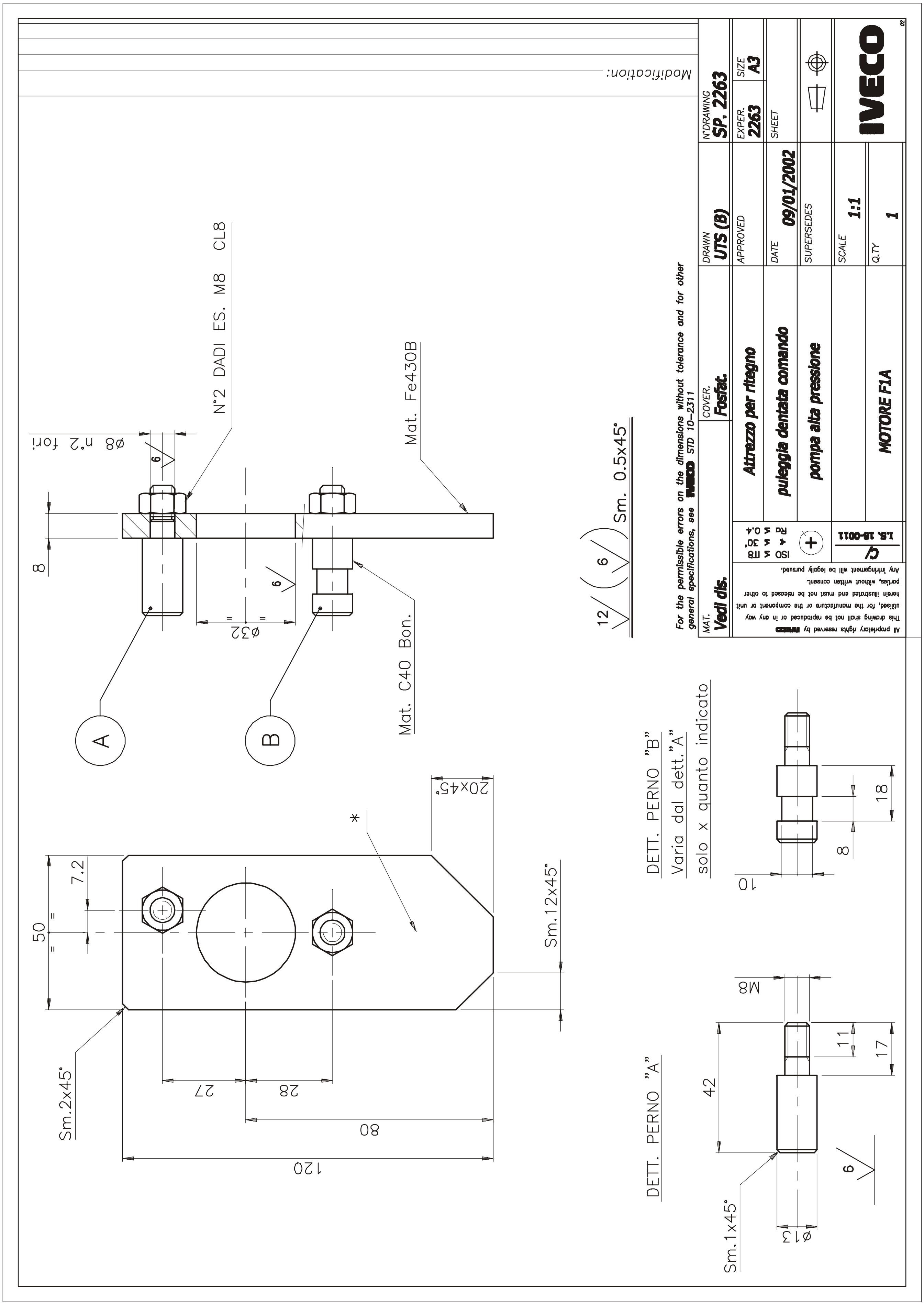
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. /	COVER. /	DRAWN UTS (B)	N°DRAWING SP. 2262
Chiave poligonale (19mm)		APPROVED	EXPER. 2262 / SIZE A4
per sensore pompa acqua		DATE 19/06/2001	SHEET
		SUPERSEDES	
		SCALE 1:1	IVECO
MOTORE F1A		Q.TY 1	

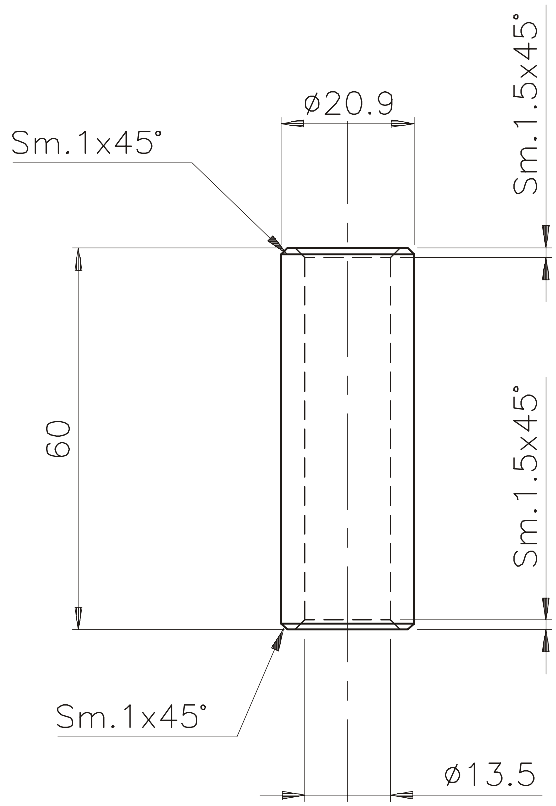
ISO ≤ IT8
∢ ≤ 30'
Ra ≤ 0.4

C/
I.S. 18-0011

02



Modification:
N°DRAWING SP. 2263
SIZE A3
EXPER. 2263
SHEET
DRAWN UTS (B)
APPROVED
DATE 09/01/2002
SUPERSEDES
SCALE 1:1
Q.TY 1
IVECO
MAT. Vedi dis.
COVER. Fosfat.
Attrezzo per ritegno
puleggia dentata comando
pompa alta pressione
MOTORE F1A
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10-2311
ISO ≤ IT8
≤ 30'
Ra ≤ 0.4
I.S. 18-0011
All proprietary rights reserved by IVECO. This drawing shall not be reproduced or in any way utilised, for the manufacture of the component or unit herein illustrated and must not be released to other parties, without written consent. Any infringement will be legally pursued.
N°2 DADI ES. M8 CL8
ø8 n°2 fori
Mat. Fe430B
Mat. C40 Bon.
Sm. 0.5x45°
ø32
A
B
20x45°
Sm.12x45°
Sm.2x45°
Sm.1x45°
7.2
50
27
28
80
120
DETT. PERNO "A"
DETT. PERNO "B"
Varia dal dett. "A"
solo x quanto indicato
42
11
17
M8
ø13
10
8
18

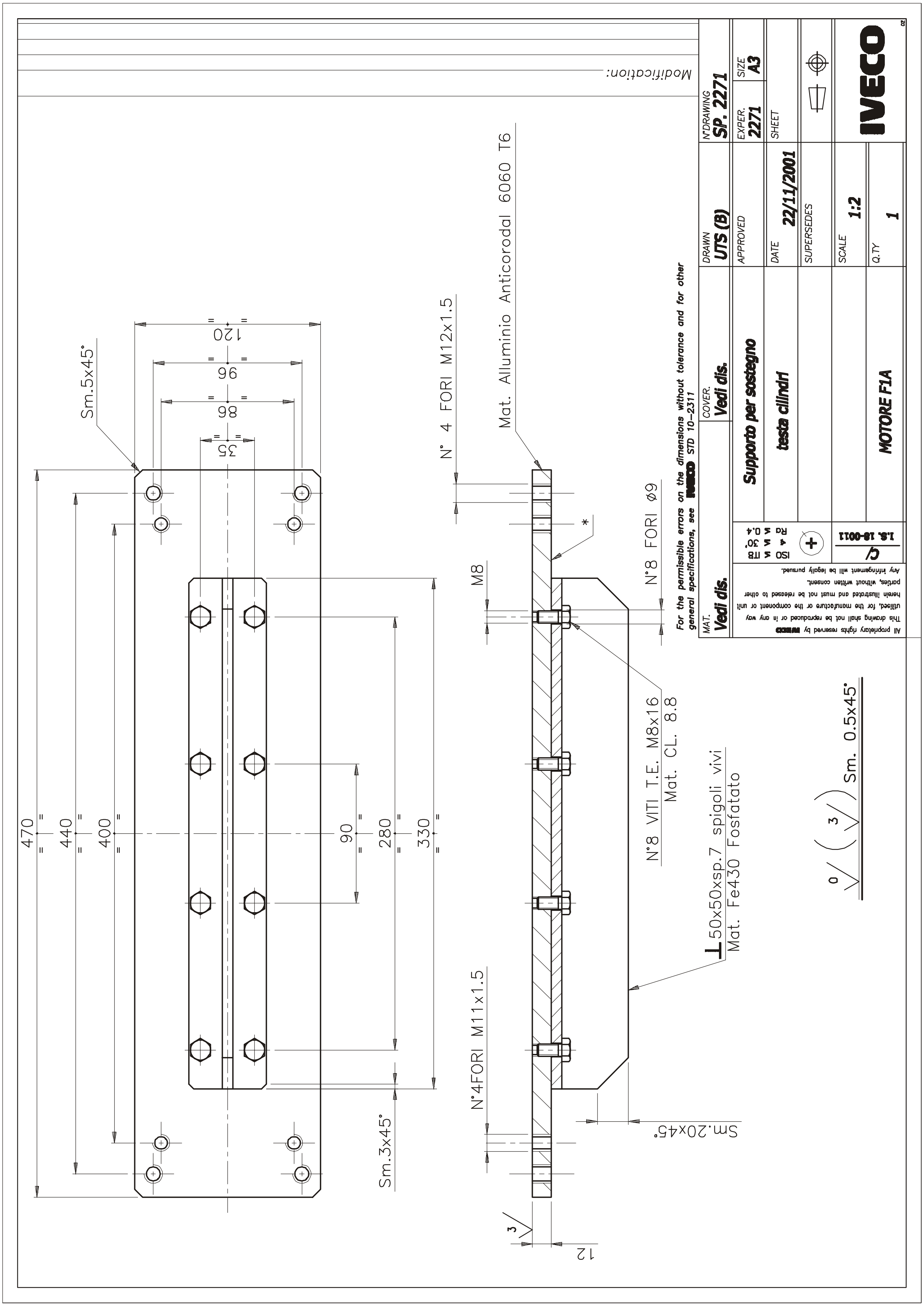


Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. **Pom / Nylon**	COVER. **/**	DRAWN **UTS (B)**	N°DRAWING **SP. 2264**
	Perni di centraggio sovratesta	APPROVED	EXPER. **2264** / SIZE **A4**
ISO ≤ IT8, ∢ ≤ 30', Ra ≤ 0.4	**e per piantaggio guarnizione**	DATE **19/06/2001**	SHEET
	guida valvole	SUPERSEDES	
C/ I.S. 18-0011		SCALE **1:1**	IVECO
	MOTORE F1A	Q.TY **2**	

02


Modification:
N°DRAWING SP. 2271
SIZE A3
EXPER. 2271
SHEET
IVECO
DRAWN UTS (B)
APPROVED
DATE 22/11/2001
SUPERSEDES
SCALE 1:2
Q.TY 1
COVER. Vedi dis.
MAT. Vedi dis.
Supporto per sostegno
testa cilindri
MOTORE F1A
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10-2311
I.S. 18-0011
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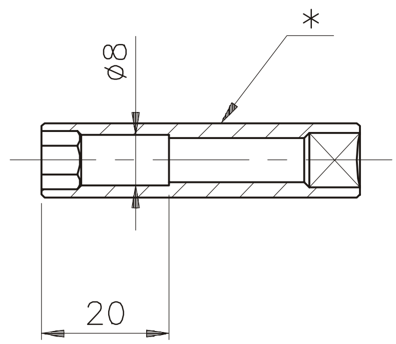
Any infringement will be legally pursued.
Mat. Alluminio Anticorodal 6060 T6
N° 4 FORI M12x1.5
N°8 FORI Ø9
M8
N°8 VITI T.E. M8x16
Mat. CL. 8.8
⊥50x50xsp.7 spigoli vivi
Mat. Fe430 Fosfatato
Sm. 0.5x45°
Sm.5x45°
Sm.3x45°
Sm.20x45°
N°4FORI M11x1.5
120
96
86
35
470
440
400
90
280
330
12

VARIA DA ART. COMMERCIALE USAG cod.235EL 1/4" – Ch.8
SOLO PER QUANTO INDICATO

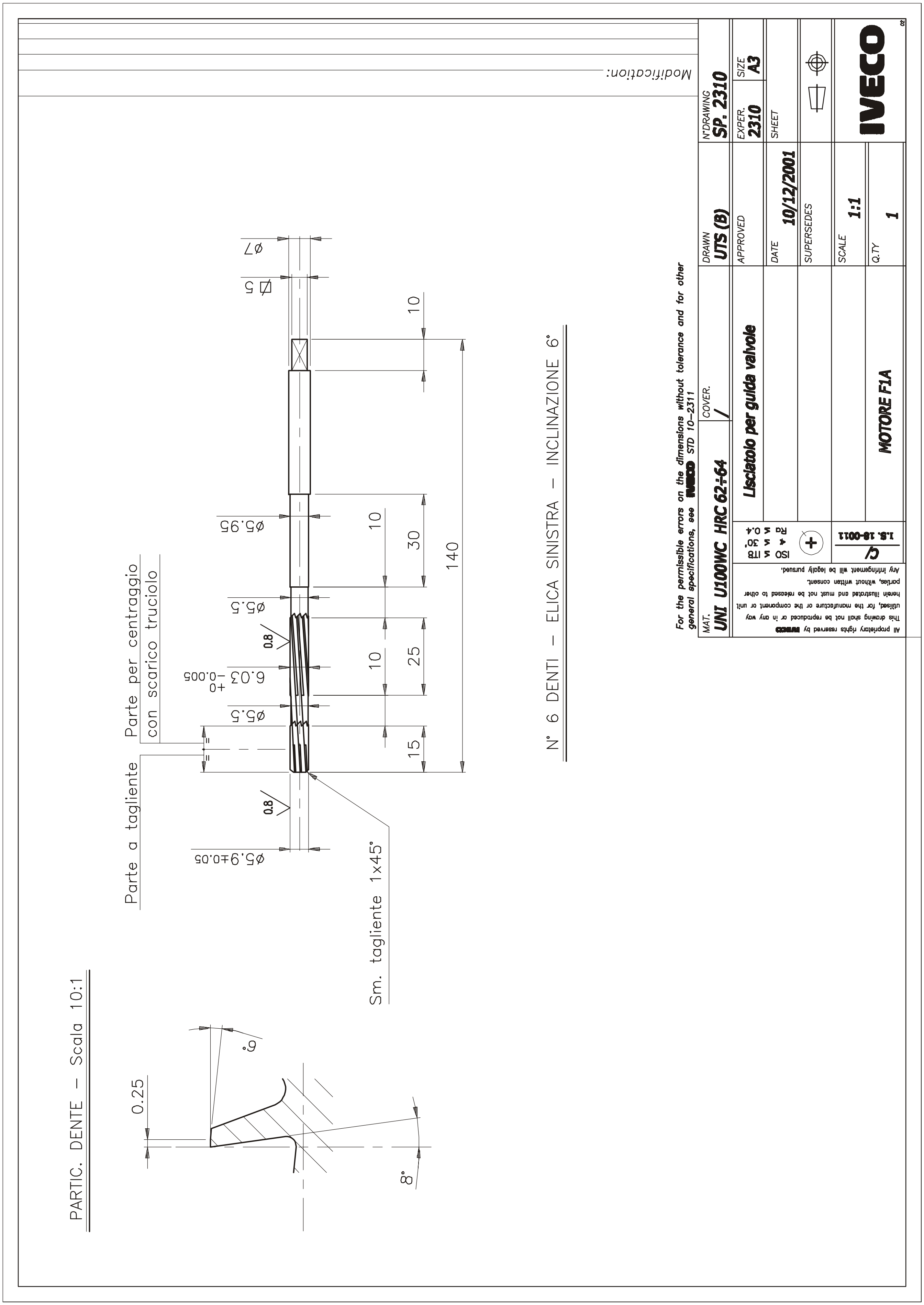


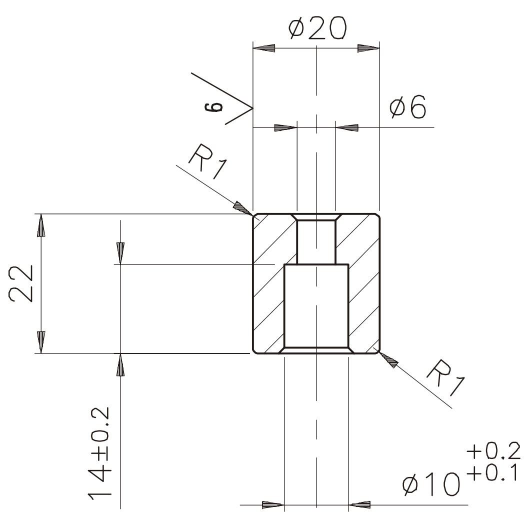
6 Sm. 0.5x45°

Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. /	COVER. /	DRAWN UTS (B)	N°DRAWING SP. 2275
ISO ≤ IT8, ∢ ≤ 30', Ra ≤ 0.4	**Bussola (8 mm) per montaggio/ smontaggio candelette**	APPROVED	EXPER. 2275 / SIZE A4
		DATE 25/07/2001	SHEET
		SUPERSEDES	
C/ I.S. 18-0011		SCALE 1:1	IVECO
	MOTORE F1A	Q.TY 1	02


Modification:
PARTIC. DENTE - Scala 10:1
0.25
6°
8°
Parte a tagliente
Parte per centraggio con scarico truciolo
Sm. tagliente 1x45°
Ø5.9±0.05
0.8
Ø5.5
6.03 +0 -0.005
Ø5.95
◻5
Ø7
15
10
25
30
140
N° 6 DENTI - ELICA SINISTRA - INCLINAZIONE 6°
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10-2311
MAT.
UNI U100WC HRC 62÷64
COVER.
/
DRAWN
UTS (B)
N°DRAWING
SP. 2310
Lisciatolo per guida valvole
APPROVED
EXPER.
2310
SIZE
A3
DATE
10/12/2001
SHEET
SUPERSEDES
SCALE
1:1
Q.TY
1
MOTORE F1A
IVECO



Modification:

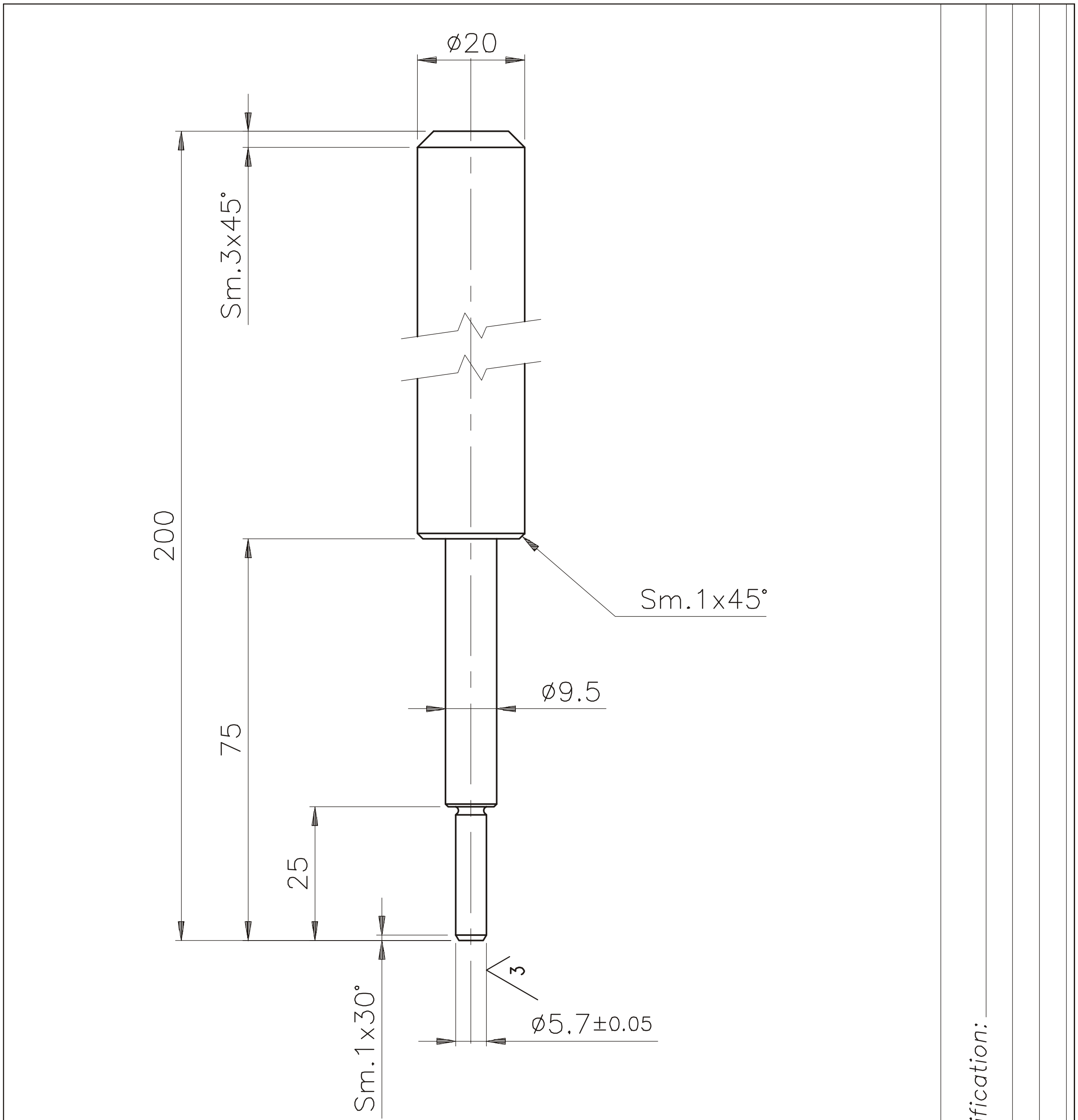
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT.	COVER.	DRAWN	N°DRAWING	
39NiCrMo3 Bon.	Fosfat.	UTS (B)	SP. 2311	
Battitoio per piantaggio		APPROVED	EXPER. 2311	SIZE A4
guida valvole		DATE 10/12/2001	SHEET	
(usare con sp. 2312)		SUPERSEDES		
		SCALE 1:1	IVECO	
MOTORE F1A		Q.TY 1		

ISO ≤ IT8
∢ ≤ 30'
Ra ≤ 0.4

C/
I.S. 18-0011

02



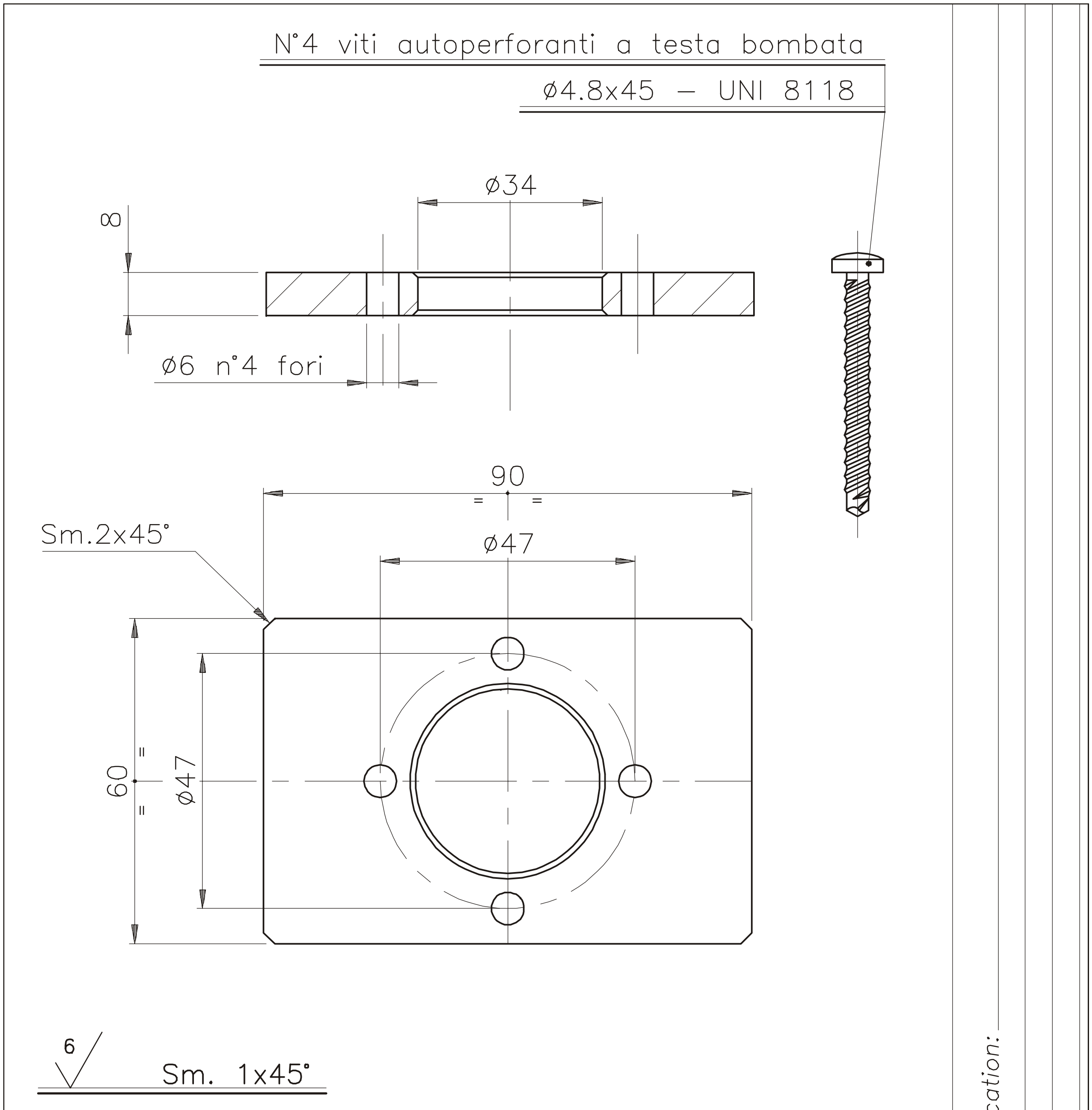
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. 39NiCrMo3 Bon.	COVER. Fosfat.	DRAWN UTS (B)	N°DRAWING SP. 2312
Battitoio per spiantaggio		APPROVED	EXPER. 2312 / SIZE A4
guida valvole		DATE 10/12/2001	SHEET
		SUPERSEDES	
		SCALE 1:1	IVECO
MOTORE F1A		Q.TY 1	

ISO ≤ IT8
∢ ≤ 30'
Ra ≤ 0.4

C/
I.S. 18-0011

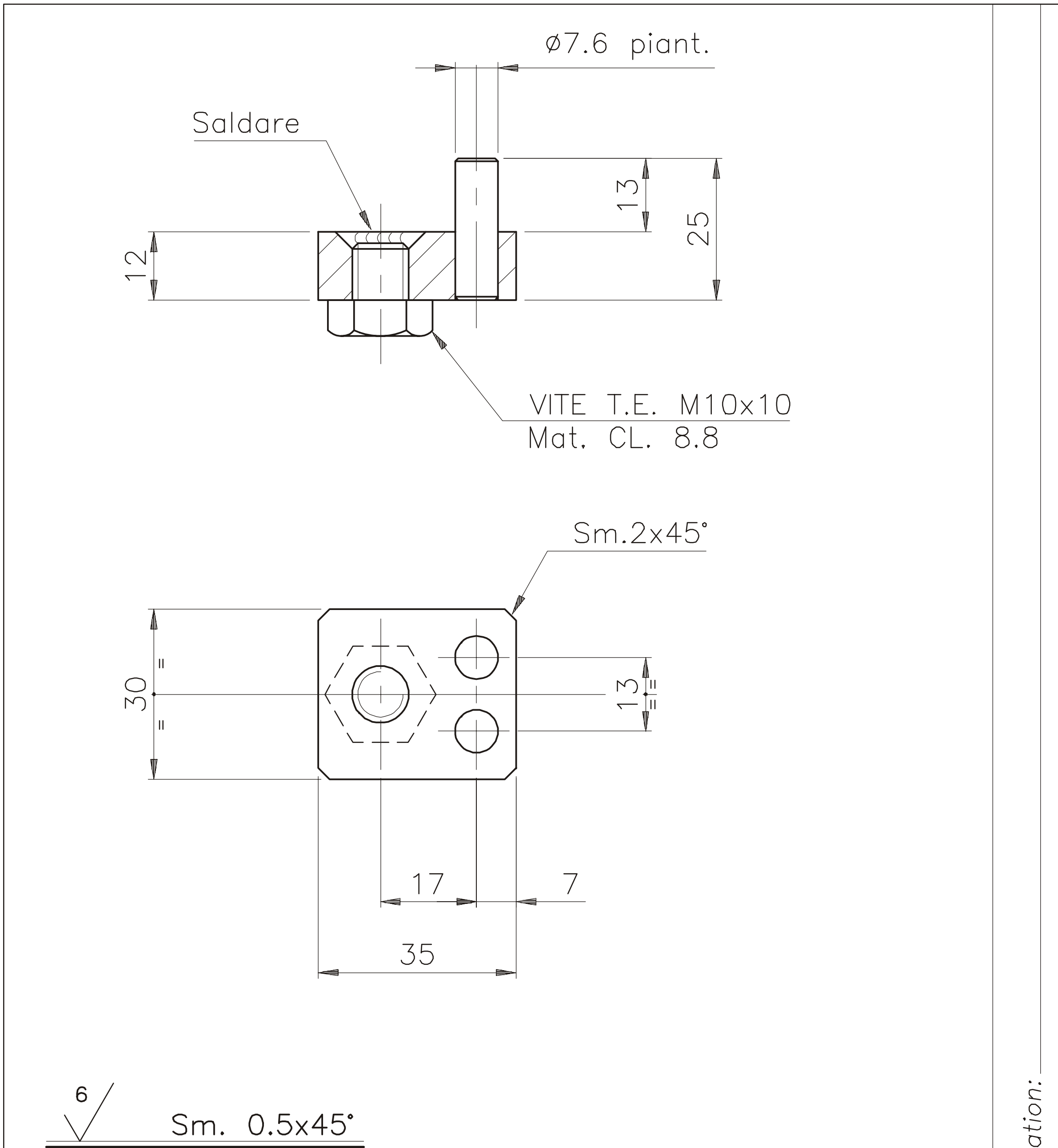
02



For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. **Fe430B**	COVER. **Fosfat.**	DRAWN **UTS (B)**	N°DRAWING **SP. 2325**
ISO ≤ IT8 / ∢ ≤ 30' / Ra ≤ 0.4	**Attrezzo per estrazione**	APPROVED	EXPER. **2325** / SIZE **A4**
	guarnizione albero distribuzione	DATE **01/02/2002**	SHEET
		SUPERSEDES	
C/ I.S. 18-0011		SCALE **1:1**	IVECO
	MOTORE F1A	Q.TY **1**	

02



For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO *STD 10–2311*

MAT. **C40 Bon.**	COVER. **Fosfat.**	DRAWN **UTS (B)**	N°DRAWING **SP.2341**
ISO ≤ ITB, ∢ ≤ 30', Ra ≤ 0.4	**Chiave per tensionamento tenditore cinghia compressore condizionatore**	APPROVED	EXPER. **2341** / SIZE **A4**
		DATE **05/03/2002**	SHEET
		SUPERSEDES	
C/ I.S. 18-0011		SCALE **1:1**	IVECO
	MOTORE F1A	Q.TY **1**	02

Appendix

SAFETY PRESCRIPTIONS
Standard safety prescriptions

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in-charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

- Keep working areas as clean as possible, ensuring adequate aeration.
- Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- Smoking in working areas subject to fire danger must be strictly prohibited.
- Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- Wear safety gloves and goggles when performing the following operations:
  - filling inhibitors or anti-frost
  - lubrication oil topping or replacement
  - utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- Wear safety helmet when working close to hanging loads or equipment working at head height level.
- Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- Use protection cream for hands.
- Change wet cloths as soon as possible
- In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.
- Do not smoke nor light up flames close to batteries and to any fuel material.
- Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- Do not execute any intervention if not provided with necessary instructions.
- Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50ºC.
- Never top up an overheated engine with cooler and utilize only appropriate liquids.
- Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- Do not leave rags impregnated with flammable substances close to the engine.
- Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- Do not utilize fast screw-tightening tools.
- Never disconnect batteries when the engine is running.
- Disconnect batteries before any intervention on the electrical system.
- Disconnect batteries from system aboard to load them with the battery loader.
- After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- Do not disconnect and connect electrical connections in presence of electrical feed.
- Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

- Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.
- Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.
- Do not modify cable wires: their length shall not be changed.
- Do not connect any user to the engine electrical equipment unless specifically approved by Iveco.
- Do not modify fuel systems or hydraulic system unless Iveco specific approval has been released. Any unauthorized modification will compromise warranty assistance and furthermore may affect engine correct working and duration.

For engines equipped with electronic gearbox:

- Do not execute electric arc welding without having priory removed electronic gearbox.
- Remove electronic gearbox in case of any intervention requiring heating over 80°C temperature.
- Do not paint the components and the electronic connections.
- Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

- Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.
- Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.
- Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.
- Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.

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Part 2
F1C ENGINES

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the F1C engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

Section 3 relates to the specific duty and is divided in four separate parts:

1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.

Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.

Installation general prescriptions are reported within the appendix.

The appendix reports general safety prescriptions to be followed by all operators whether being in-charge of installation or maintenance, in order to avoid serious injury.

UPDATING

Section	Description	Page	Date of revision
1	Correspondence between technical code and commercial code	3	February 2006

SECTION 1

General specifications

Page

CORRESPONDENCE BETWEEN TECHNICAL CODE AND COMMERCIAL CODE

Technical Code	Commercial Code
F1CE0481B*....	S 30 ENT C
F1CE0481A*....	S 30 ENT C

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LUBRICATION
General

The engine is lubricated by forced circulation performed by the following parts:

- a gear oil pump with built-in depressor (GPOD);
- a pressure relief valve integrated in the oil pump;
- a heat exchanger made up of five elements;
- A double filtration oil filter with built-in safety valve.

Operation (see Figure 1)

Engine oil is drawn up from the sump by the oil pump via the suction strainer and delivered under pressure to the heat exchanger where it is cooled.
The oil continues through the oil filter and goes to lubricate the relevant parts through ducts or pipes.
At the end of the lubrication cycle, the oil returns to the sump by gravity. The oil filter can be excluded by the safety valve built into it if it gets clogged.
In addition, the lubricating oil feeds the chain hydraulic tightening devices for the control of the auxiliary elements and the timing system and the hydraulic tappet.

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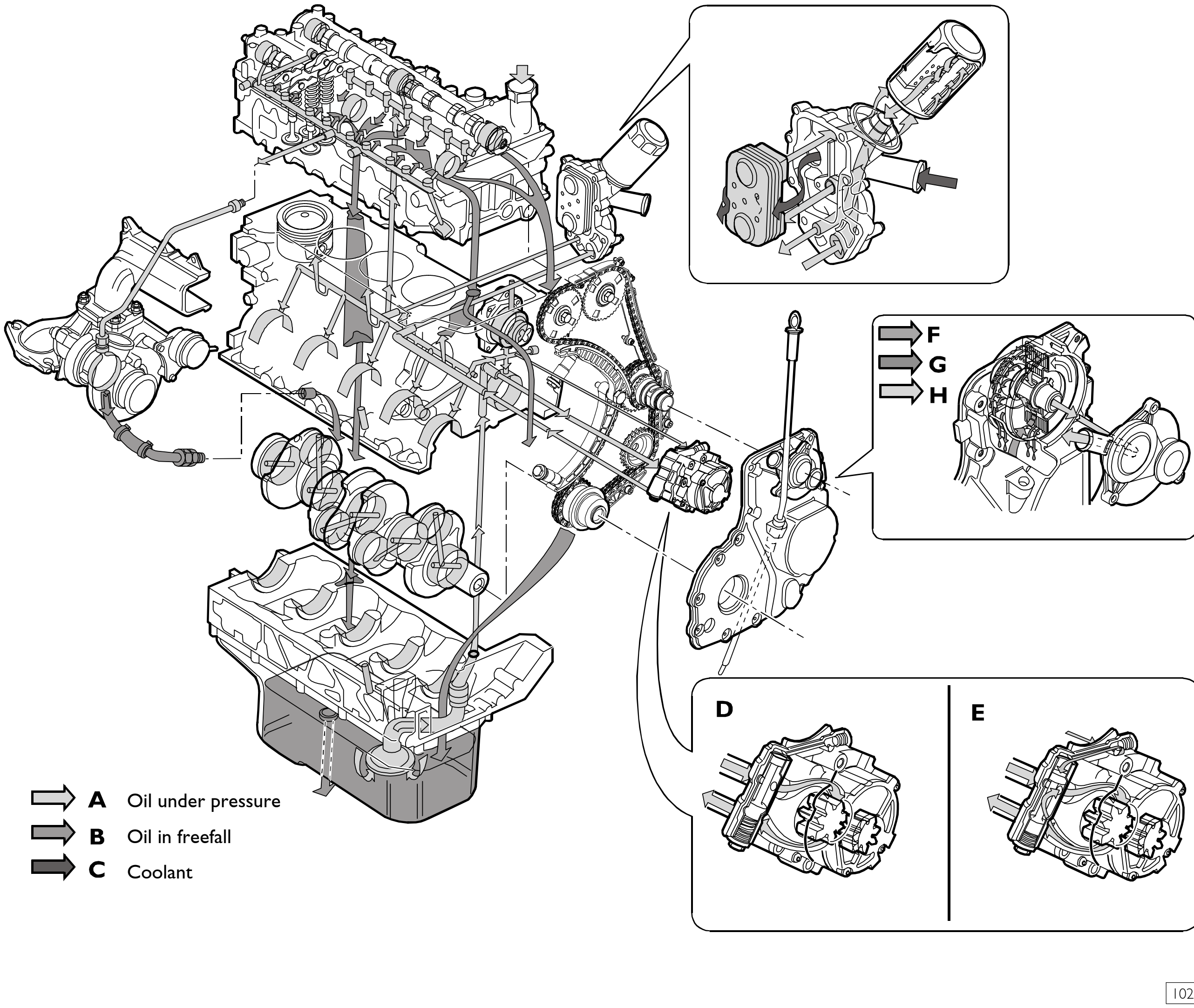
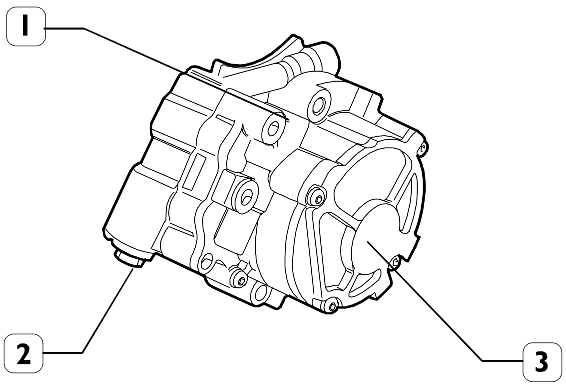
Figure 1



A. Pressure regulating valve closed - B. Pressure regulating valve open.

OIL PUMP/DEPRESSOR UNIT

Figure 2



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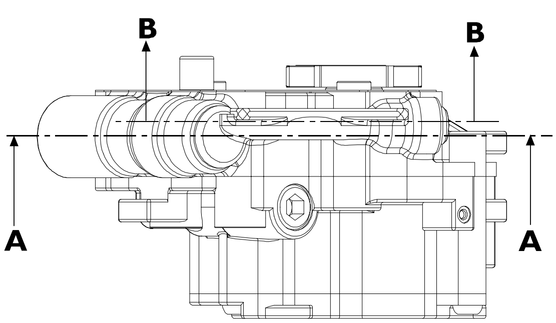
1. Oil pump - 2. Oil pressure adjusting valve - 3. Depressor.

NOTE Should the unit be faulty, not due to the oil pressure adjusting valve, change the whole unit.

Figure 3



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SECTIONS OF OIL PUMP/DEPRESSOR UNIT

1. Oil input pipe from cylinder block - 2. Oil suction pipe - 3. Oil pressure adjusting valve - 4. Oil delivery pipe - 5. Depressor air suction pipe - 6. Depressor oil suction pipe.

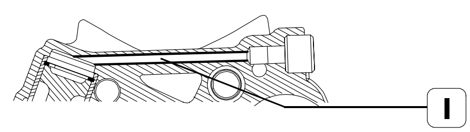
Oil pump

Characteristic data

transmission ratio	1	
displacement	23.52	cm^3
pumping diameter	49.5	mm
number of teeth	7	
height	16	mm
oil pump minimum speed	780	rpm
oil pump max. speed	3500	rpm
oil pump over-revs	4200	rpm
oil pump forced over-revs	4900	rpm
speed	3500	rpm
torque	-	Nm
power draw (calc.)	-	W

Oil temperature: 100°C – closed recirculation – max. outlet pressure 5 bars	
engine speed rpm (oil pump speed – rpm)	capacity (l/min)
780 (862)	
3500 (4485)	

Figure 4



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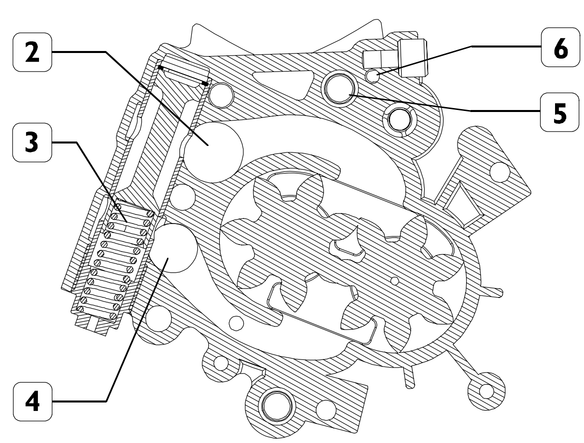
SECTION B-B

Figure 5



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SECTION A-A

Vacuum pump

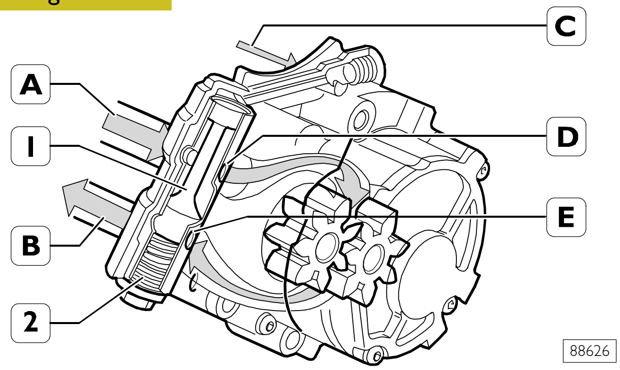
The vacuum pump (2, NO TAG), with radial blades, is also incorporated in the GPOD (1, NO TAG). It is driven directly by the oil pump.

transmission ratio	1	
displacement	150	cm^3
volume to drain	4.5	litres
chamber diameter	65	mm
rotor diameter	45.5	mm
cam	7.5	mm
number of blades	3	
height	34	mm
vacuum pump minimum speed	780	rpm
vacuum pump max. speed	3500	rpm
vacuum pump over-revs	4200	rpm
vacuum pump forced over-revs	4900	rpm
theoretical flow rate at minimum (air)	-	l/min
actual flow rate at minimum (air) – at atmospheric pressure	-	l/min
Theoretical speed at max. speed – (air)	-	l/min
Actual flow rate at max. speed – (air) at atmospheric pressure	-	l/min
measured power draw (maximum)		
speed	3500	rpm
torque	-	Nm
power draw (calc.)	-	W

Oil temperature: 100°C – engine speed 780 rpm (pump speed 994 rpm)			
tank (litres)	vacuum (bar)	0.5	0.8
4.5	time (sec)	4.5	12.5
9		9.5	26.0

Oil pressure adjusting valve

Figure 6



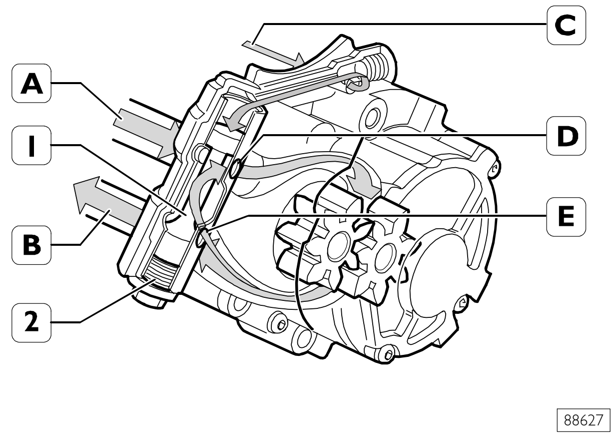
1. Oil input pipe from cylinder block - 2. Oil suction pipe - 3. Oil pressure adjusting valve - 4. Oil delivery pipe - 5. Depressor air suction pipe - 6. Depressor oil suction pipe.

Pressure at opening start: 4.4 bar

Description of oil pressure adjusting valve closed

If in pipe **C** the oil pressure is below 4.4 bar, the valve (1) closes the holes **D** - **E**.

Figure 7

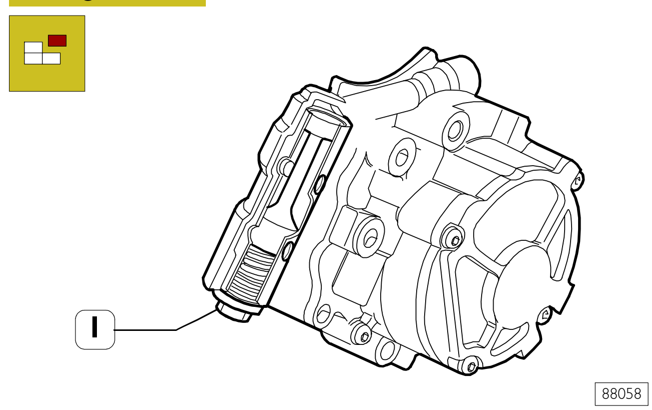


Oil pressure adjusting valve open

If in pipe **C** the oil pressure is equal or above 4.4 bar, the valve (1), as a result of the pressure itself, wins through the spring reaction (2) and goes down, thus opening communication between the delivery pipe **A** and the suction pipe **B**, through draining holes **D**-**E**, and therefore the pressure drops.
When the pressure falls below 4.4 bar, the spring (2) takes the valve (1) to the initial position of closed valve.

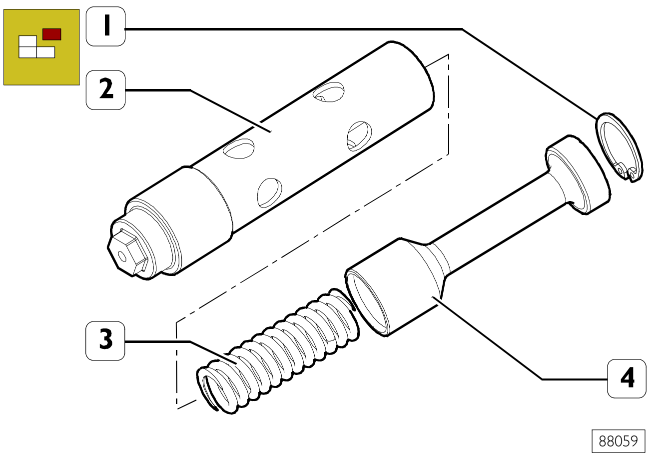
Disassembly

Figure 8



Use the suitable wrench to remove the oil pressure adjusting valve (1) from the oil pump.

Figure 9

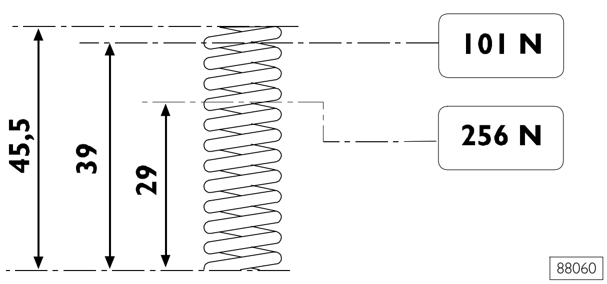


PARTS COMPRISING THE OIL PRESSURE CONTROL VALVE

1. Split ring – 2. Valve – 3. Spring – 4. Valve casing.

Use the suitable pliers to remove the snap ring (1), take off the valve (4) and the spring (3) from the valve body (2).

Figure 10



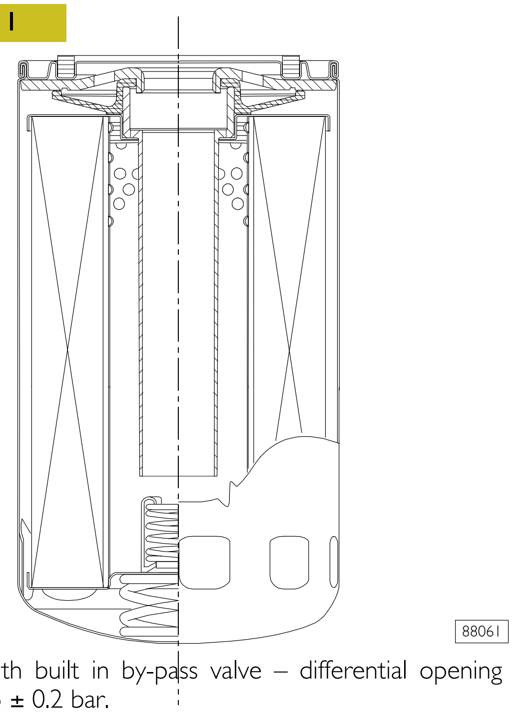
MAIN DATA OF THE OIL PRESSURE CONTROL VALVE SPRING

Assembly

For refitting, reverse the removal operations.

Oil filter

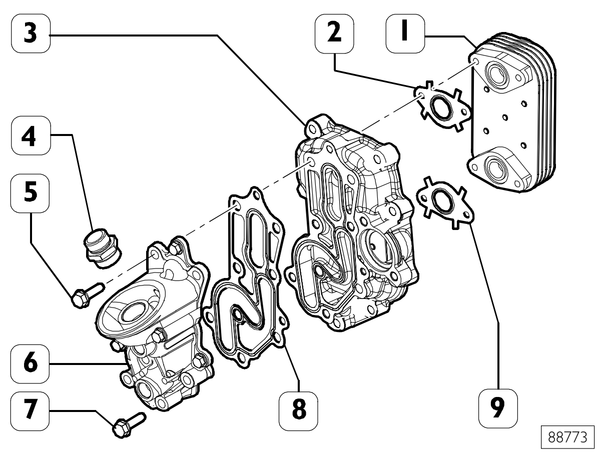
Figure 11



Oil filter with built in by-pass valve – differential opening pressure 2.5 ± 0.2 bar.

Heat exchanger

Figure 12



HEAT EXCHANGER COMPONENT DETAILS
1. Heat exchanger made up of five elements - 2. Gasket - 3. Box - 4. Pipe union - 5. Screw - 6. Oil filter support - 7. Screw - 8. Heat exchanger box - 9. Gasket.

Disassembly

Remove the screws (5) and take off the heat exchanger (1) from the box (3) with the gasket (8).
Remove the screws (7) and take off the oil filter support (6) from the box (3).

Assembly

For refitting, reverse the removal operations and observe the following warnings.
Clean accurately the heat exchanger (1).
Always change the gaskets (2, 9 and 8). Apply LOCTITE 577 on the threading of the pipe union (4) (if removed), drive it in the support (1) and tighten it to the prescribed torque. Tighten the screws to the prescribed torque.

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Figure 13

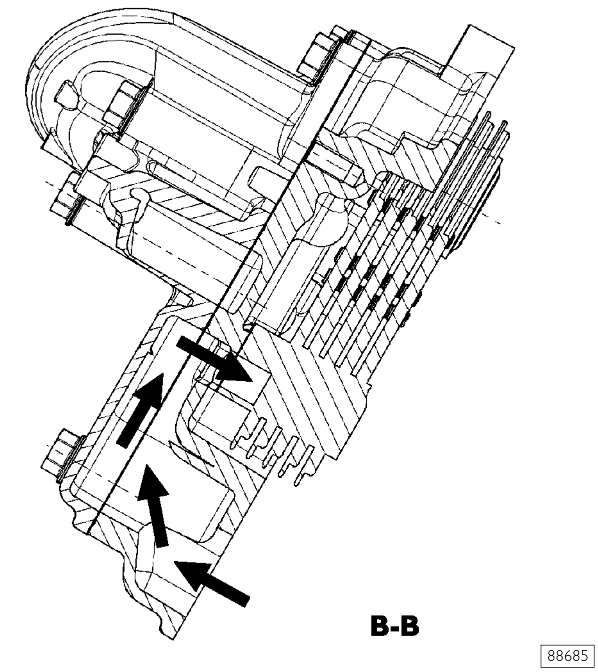


Figure 14

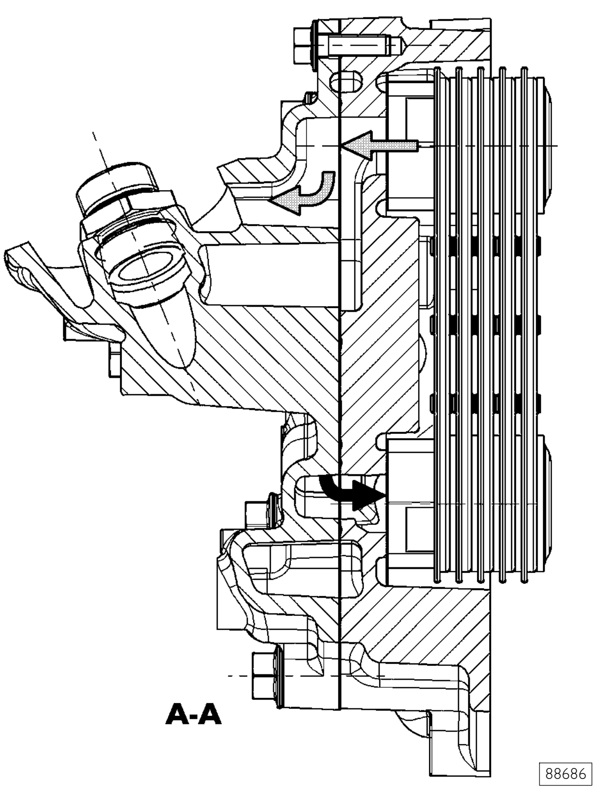


Figure 15

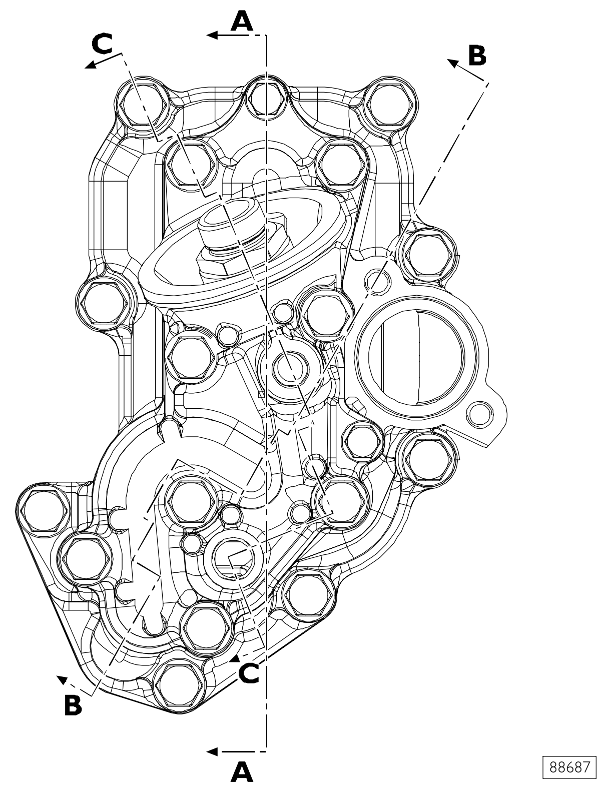
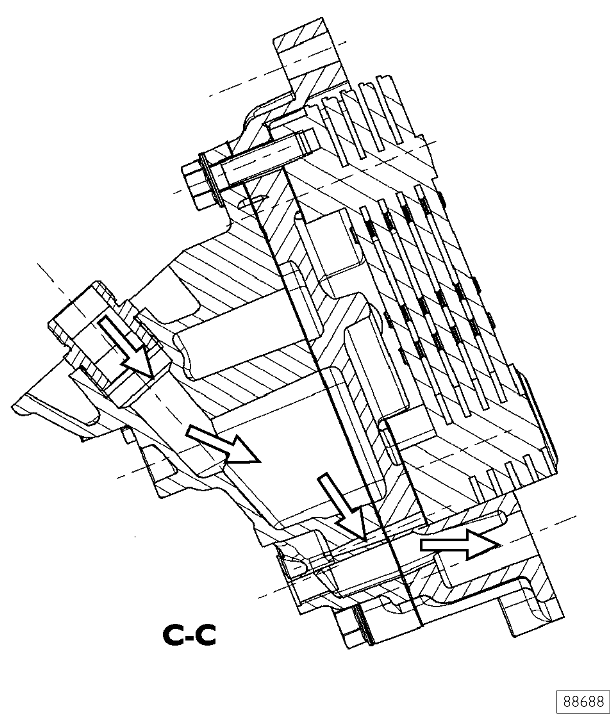


Figure 16



HEAT EXCHANGER SECTIONS

Oil flow from heat exchanger to oil filter

Oil flow from oil filter to cylinder block

Oil flow from cylinder block to heat exchanger

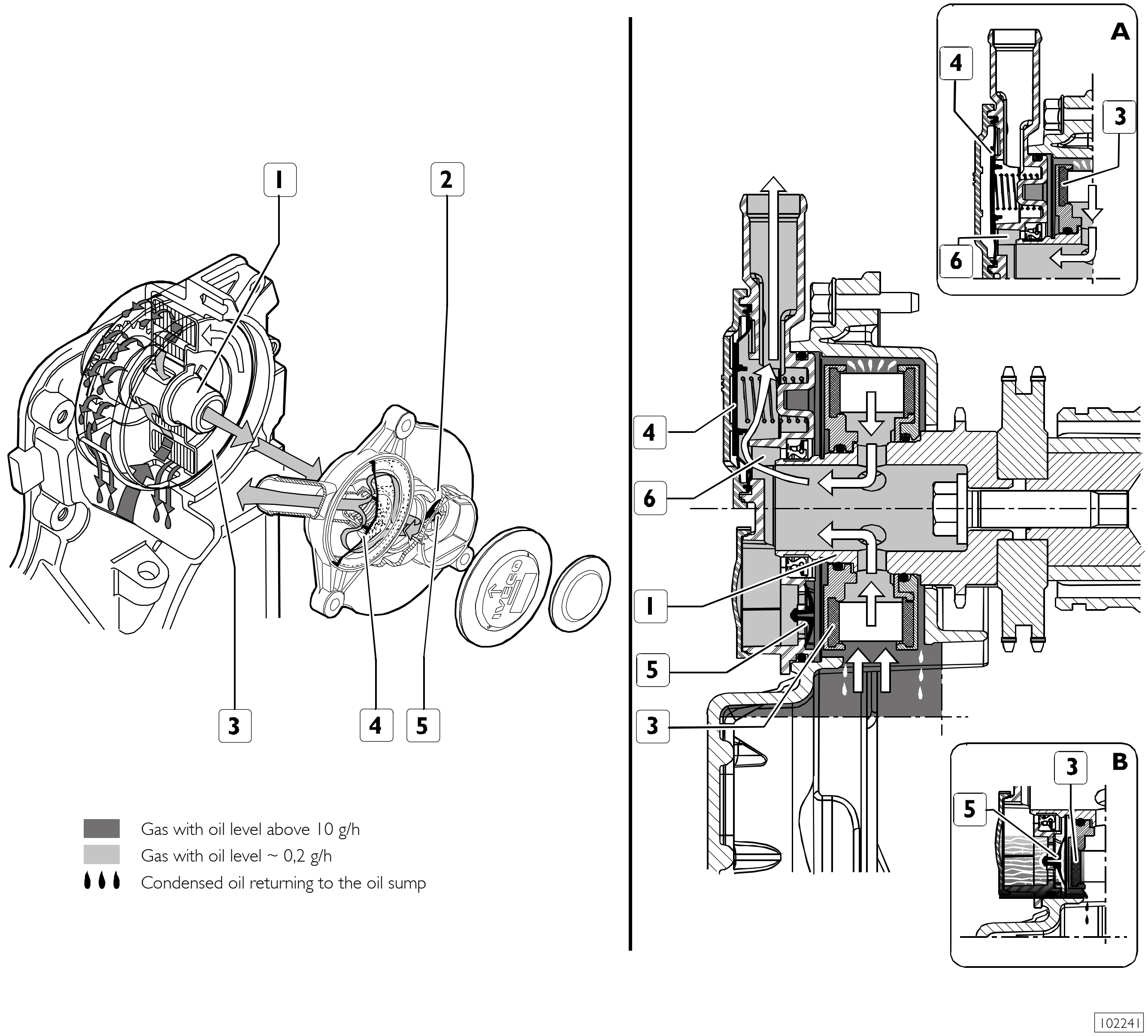
Oil vapour recirculation (Blow-by)

Part of the gas produced by the combustion during the engine operation blows by the piston snap ring ports, in the oil sump, and mixes with the oil vapours present in the oil sump. This mixture, conveyed from the chain compartment to the top, is partially separated from the oil by means of a device situated on the top side of the distribution cover and is introduced in the air suction system. This device consists mainly of a rotating filter (3), fit flush on the stem (1), a high pressure/shaft control and a cover (2) where the valves (4 and 5), usually closed, are fitted. The diaphragm valve (4) regulates the partially purified mixture and keeps the pressure inside the chain compartment around a value of ~ 10 ÷ 15 mbar.
The umbrella valve (5) discharges some of the oil still present in the mixture coming from the filter (3) in the chain compartment and the oil condenses in the chamber (6).

Operation

The mixture which passes through the rotating filter (3) is partially purified from the oil particles, as a result of centrifugation, and so these particles condense on the cover walls to return to the lubrication circuit. The resulting purified mixture is let in through the stem holes (1) and the diaphragm valve consensus (4) inside the air vent upstream of the turbocharger. The opening/closing of the valve (4) depends mainly in the ratio between the pressure operating the diaphragm (4) and the depression below it. The oil still present in the mixture coming from the rotating filter (3) and which condenses in the chamber (6) is drained into the chain compartment through the umbrella valve (5), when the pressure that keeps it closed drops as a result of the engine stop.

Figure 17


1
2
3
4
5
4
6
1
5
3
A
4
3
6
B
3
5
Gas with oil level above 10 g/h
Gas with oil level ~ 0,2 g/h
Condensed oil returning to the oil sump
102241

COOLING

Description

The engine cooling system is the type with forced circulation in a closed circuit. It comprises the following parts:

- An expansion tank whose plug has two valves incorporated in it: an outlet and an inlet, which govern the pressure of the system.
- A coolant level sensor at the base of the expansion tank.
- A pressure switch (3) notifies EDC central unit when pressure inside expansion tank exceeds 0.4 bar value; in this case, the central unit reduces engine performance level by modifying injection flow rate (De-rating).
- An engine cooling module to dissipate the heat taken from the engine by the coolant with a heat exchanger for the intercooler.
- A heat exchanger to cool the lubricating oil.
- A centrifugal water pump incorporated in the crankcase.
- An electric fan comprising an electromagnetic coupling on whose shaft a hub turns idle that is fitted with an axially mobile metal plate on which is mounted the impeller.
- A 3-way thermostat governing the circulation of the coolant.

Operation

The water pump driven by a poly-V belt by the crankshaft sends coolant into the crankcase and with a greater head into the cylinder head.
When the coolant temperature reaches and exceeds the working temperature, it causes the thermostat to open and the fluid is channelled from here to the radiator and cooled by the fan.
The pressure in the system due to the change in temperature is governed by the outlet (2) and inlet (1) valves incorporated in the expansion tank filler plug (detail A).
The outlet valve (2) has a twofold function:

- to keep the system slightly pressurized so as to raise the boiling point of the coolant;
- to discharge into the atmosphere the excess pressure produced in case of high coolant temperatures.

The function of the inlet valve (1) is to permit transferring the coolant from the expansion tank to the radiator when a lower pressure is created in the system due to the reduction in volume of the coolant as a result of its temperature lowering.
Outlet valve opening 1 ± 0.1 kg/cm^2.
Inlet valve opening 0.005 – 0.02 kg/cm^2.

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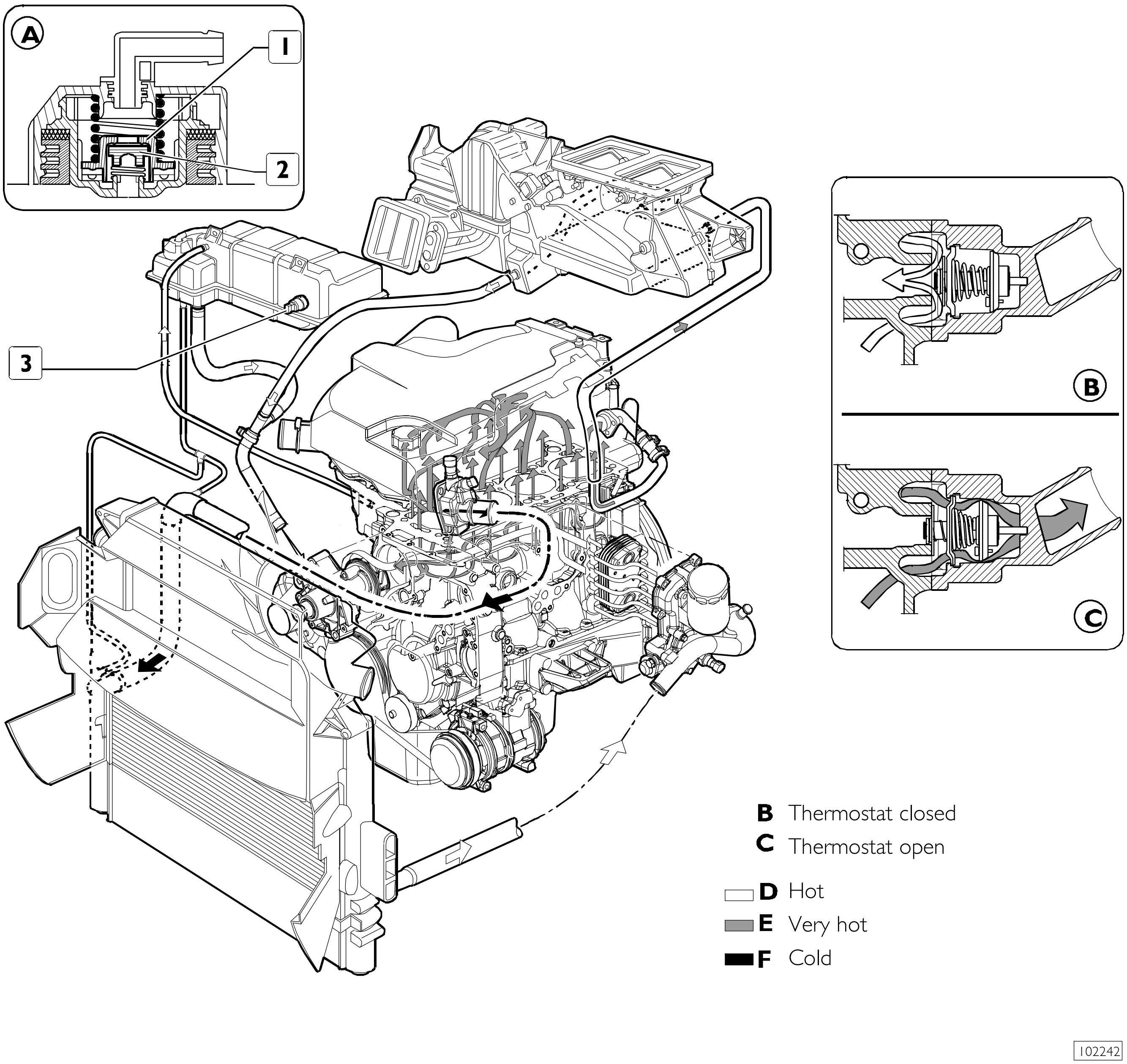
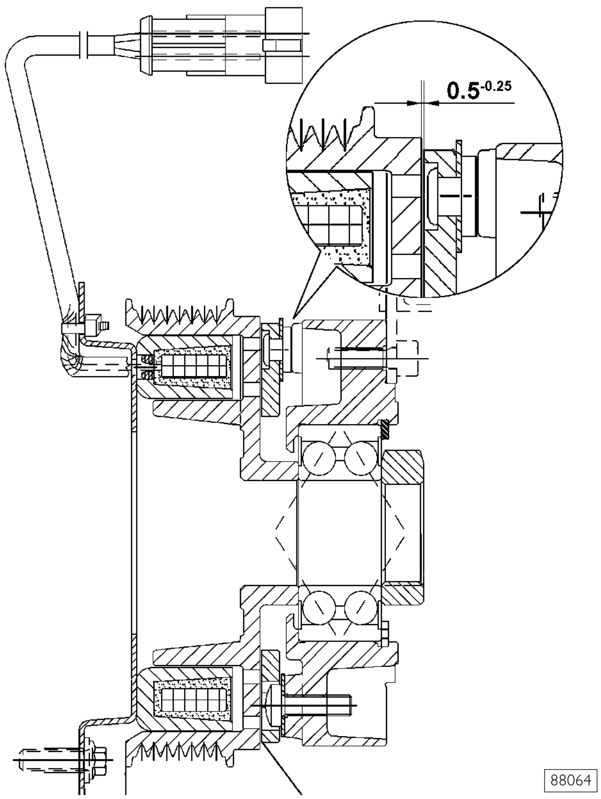
Figure 18 (If available)



Electromagnetic pulley (if available)

Figure 19



CROSS-SECTION OF THE ELECTROMAGNETIC JOINT

Characteristics

Transmissible torque at 20°C with clutch run in	85 Nm
Voltage	12 Volts
Power input at 20°C	48 W

The electric fan control relay is activated or deactivated according to the temperatures of: the engine coolant, the fuel supercharging air and the pressure of the air conditioner fluid (if present).

Turbocharging air temperature

It activates at > 75°C and deactivates at < 65°C.
Coolant temperature (if the sensor is not defective)
It activates at > 96°C and deactivates at < 84°C.

Fuel temperatures

(if the coolant temperature sensor is acknowledged to be defective by the EDC control unit)
It activates at > 20°C and deactivates at < 10°C.

With climate control system

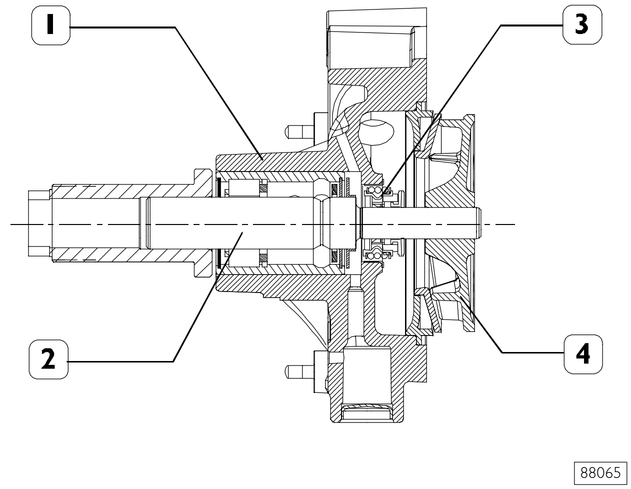
With pressure in the system

it turns on	18.5 ± 0.98 bar
it turns off	14.58 ± 0.98 bar

Water pump

The water pump cannot be overhauled. In case of coolant leaking from the seal or damage, it must be replaced.

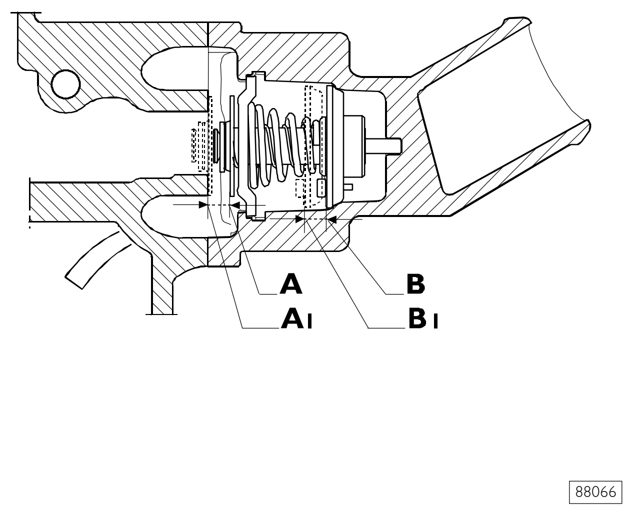
Figure 20



LONGITUDINAL CROSS-SECTION OF THE WATER PUMP
1. Pump casing – 2. Pump drive shaft together with bearing – 3. Seal – 4. Impeller.

Thermostat

Figure 21

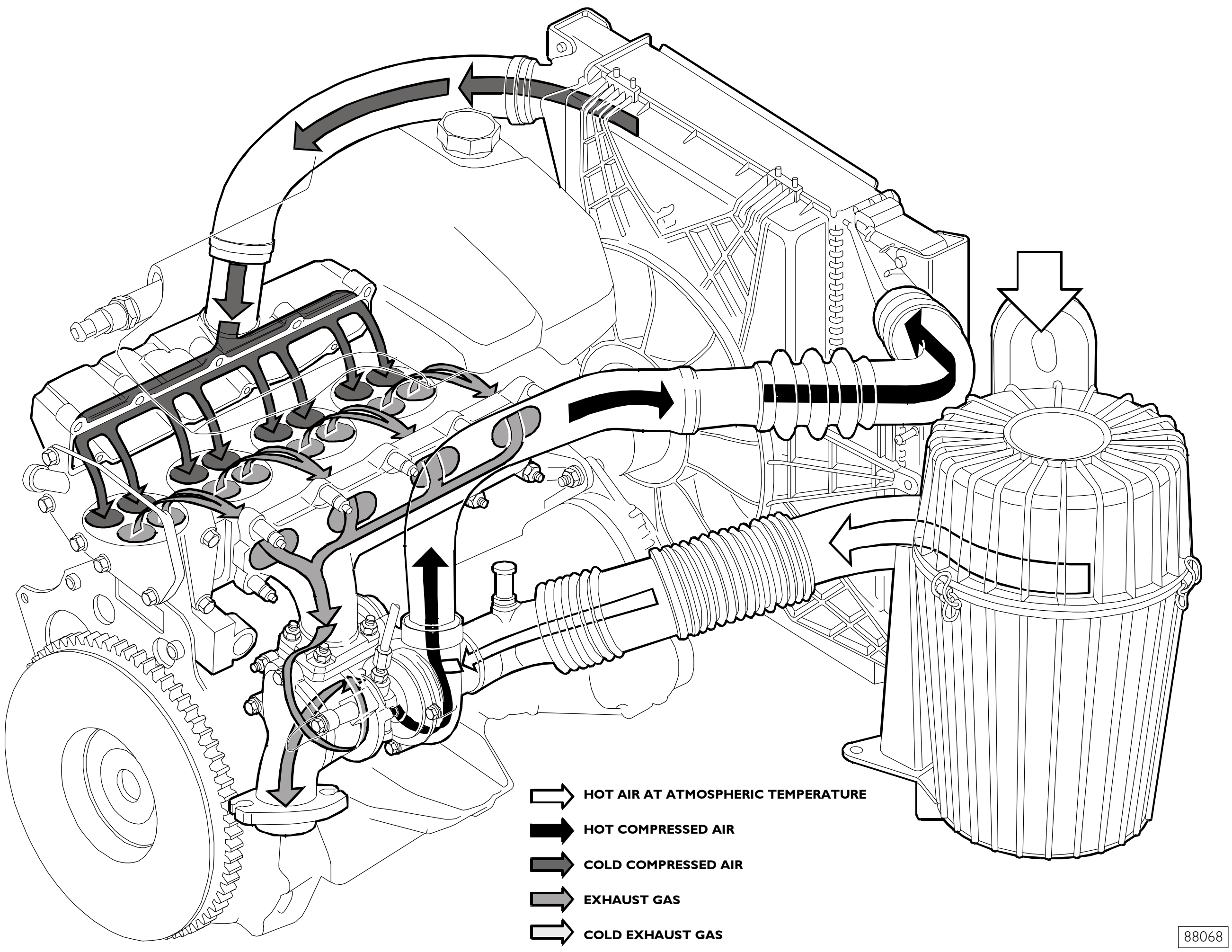


The by-pass thermostat (1) needs no adjustment.
If there is any doubt about its operation, replace it.
The thermostat casing is fitted with the thermometric switch/transmitter and water temperature sensor.

A. – A1 Start of stroke at 79 ± 2 °C.
B. Valve (1) stroke at 94 ± 2 °C ≥ 7 mm.
B1 Valve (2) stroke 94 ± 2 °C, 6.4 mm
The stroke of 7 mm less than 60''.

TURBOCHARGING

Figure 22 (If available)



TURBOCHARGING DIAGRAM

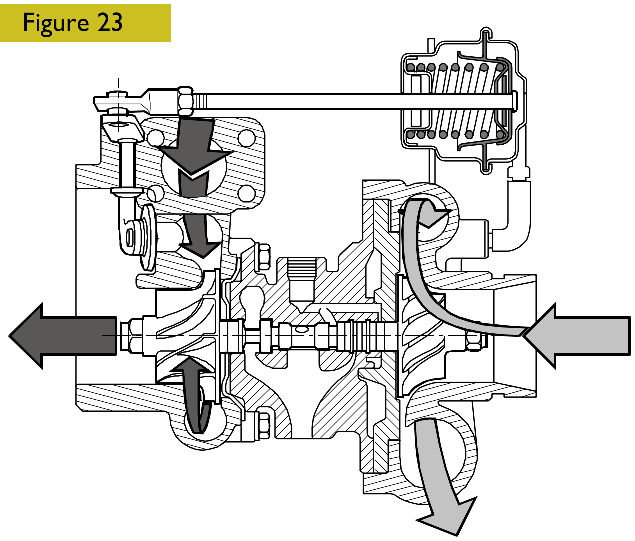
Description

The turbocharging system comprises an air filter, turbocharger and intercooler.
The air filter is the dry type comprising a filtering cartridge to be periodically replaced.

The function of the turbocharger is to use the energy of the engine's exhaust gas to send pressurized air to the cylinders.
The intercooler comprises a radiator included in the engine coolant radiator and its function is to lower the temperature of the air leaving the turbocharger to send it to the cylinders.

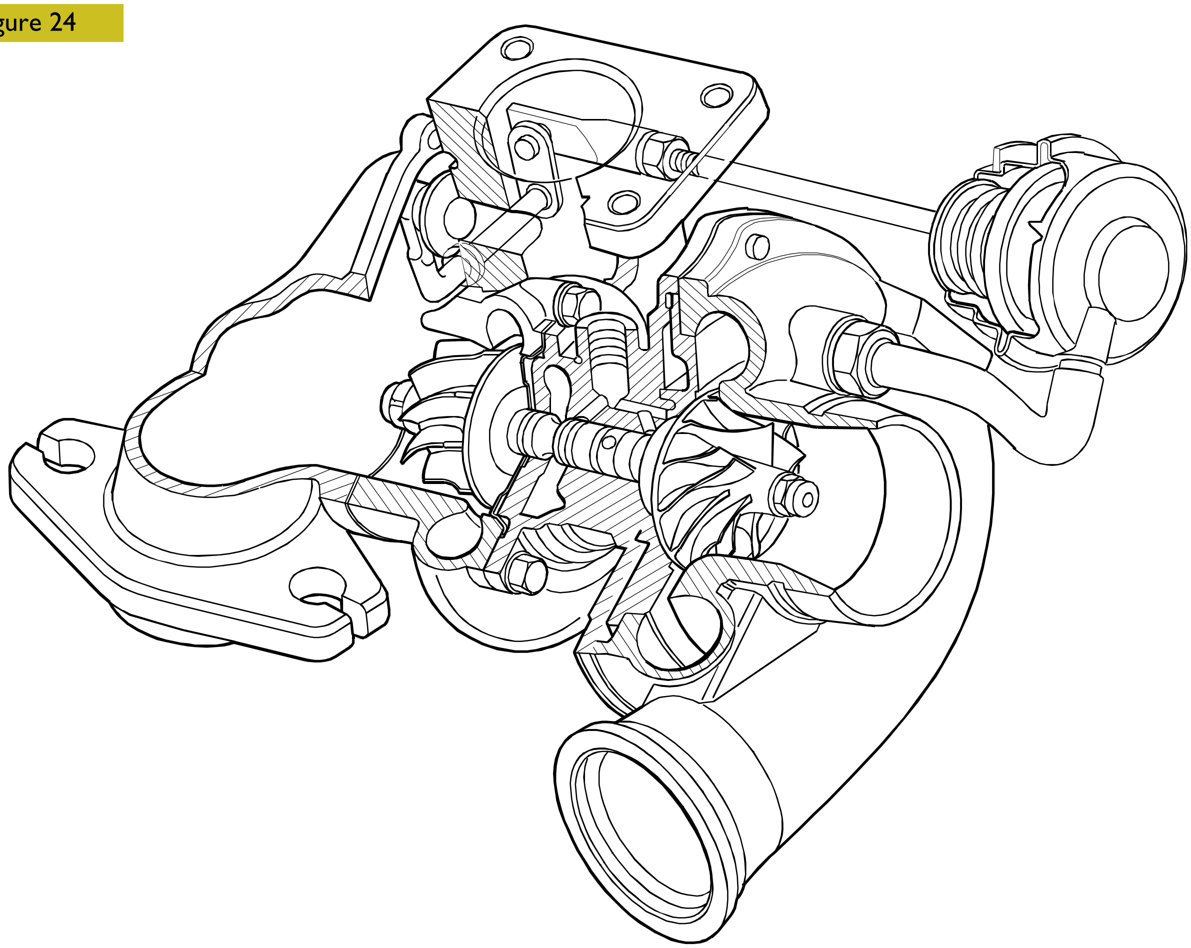
Turbocharger type **MITSUBISHI TD 4 HL-13T - 6**

Figure 23



A. THROTTLE VALVE SHUT B. THROTTLE VALVE OPEN

Figure 24



The turbocharger installed on the engine F1C AE0481 A (136 CV) is fitted with pressure relief valve (waste-gate).
It is basically composed of:

- ❑ a central casing housing a shaft supported by bushings at whose opposite ends are fitted the turbine wheel and the compressor rotor;
- ❑ a turbine casing and a compressor casing mounted on the end of the central body;
- ❑ a pressure relief valve applied on the turbine body. Its function is to choke the output of the exhaust gases (detail B) and send part of them directly into the exhaust pipe, when the supercharging pressure downstream of the turbocharger is above the rated valued;

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SECTION 2

Fuel

OPERATION

In this injection system, the pressure regulator, located upstream from the high-pressure pump, governs the flow of fuel needed in the low-pressure system. Afterwards, the high-pressure pump correctly supplies the hydraulic accumulator.

This solution, pressurizing solely the necessary fuel, improves the energy efficiency and limits heating the fuel in the system. The relief valve fitted on the high-pressure pump has the function of keeping the pressure, at the pressure regulator inlet, constant at 5 bars; irrespective of the efficiency of the fuel filter and of the system upstream. The action of the relief valve causes an increase in the flow of fuel in the high-pressure pump cooling circuit.

The high-pressure pump continually keeps the fuel at the working pressure, irrespective of the timing and the cylinder that is to receive the injection and accumulates it in a duct common to all the electro-injectors.

At the electro-injector inlet, there is therefore always fuel at the injection pressure calculated by the electronic control unit.

When the solenoid valve of an electro-injector is energized by the electronic control unit, fuel taken straight from the hydraulic accumulator gets injected into the relevant cylinder.

The hydraulic system is made out of a low-pressure fuel recirculation circuit and a high-pressure circuit.

The high-pressure circuit is composed of the following pipes:

- pipe connecting the high-pressure pump outlet to the Rail;
- hydraulic accumulator;
- pipes supplying the electro-injectors.

The low-pressure circuit is composed of the following pipes:

- fuel intake pipe from the tank to the pre-filter;
- pipes supplying the mechanical supply pump and the pre-filter;
- pipes supplying the high-pressure pump via the fuel filter.

The fuel system is also fitted with the fuel exhaust circuit and the electric injectors.

According to the high performance of this hydraulic system, for reasons of safety it is necessary to:

- avoid connecting high-pressure pipe fittings with approximate tightening;
- avoid disconnecting the high-pressure pipes with the engine running (NEVER try bleeding, which is both pointless and dangerous).

The integrity of the low-pressure circuit is also essential for the system to work properly; it is therefore necessary to avoid all manipulation and modifications and act only in the event of leakage.

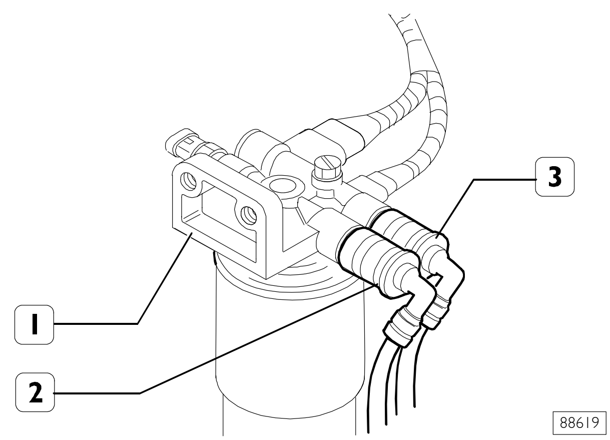
HYDRAULIC SYSTEM

The hydraulic system is composed of:

- tank
- fuel pre-filter
- electric supply pump
- fuel filter
- high pressure supply pump with supply pump built inpressure regulator
- manifold (rail)
- electro-injectors
- supply pipes and fuel recirculation

Fuel pipes

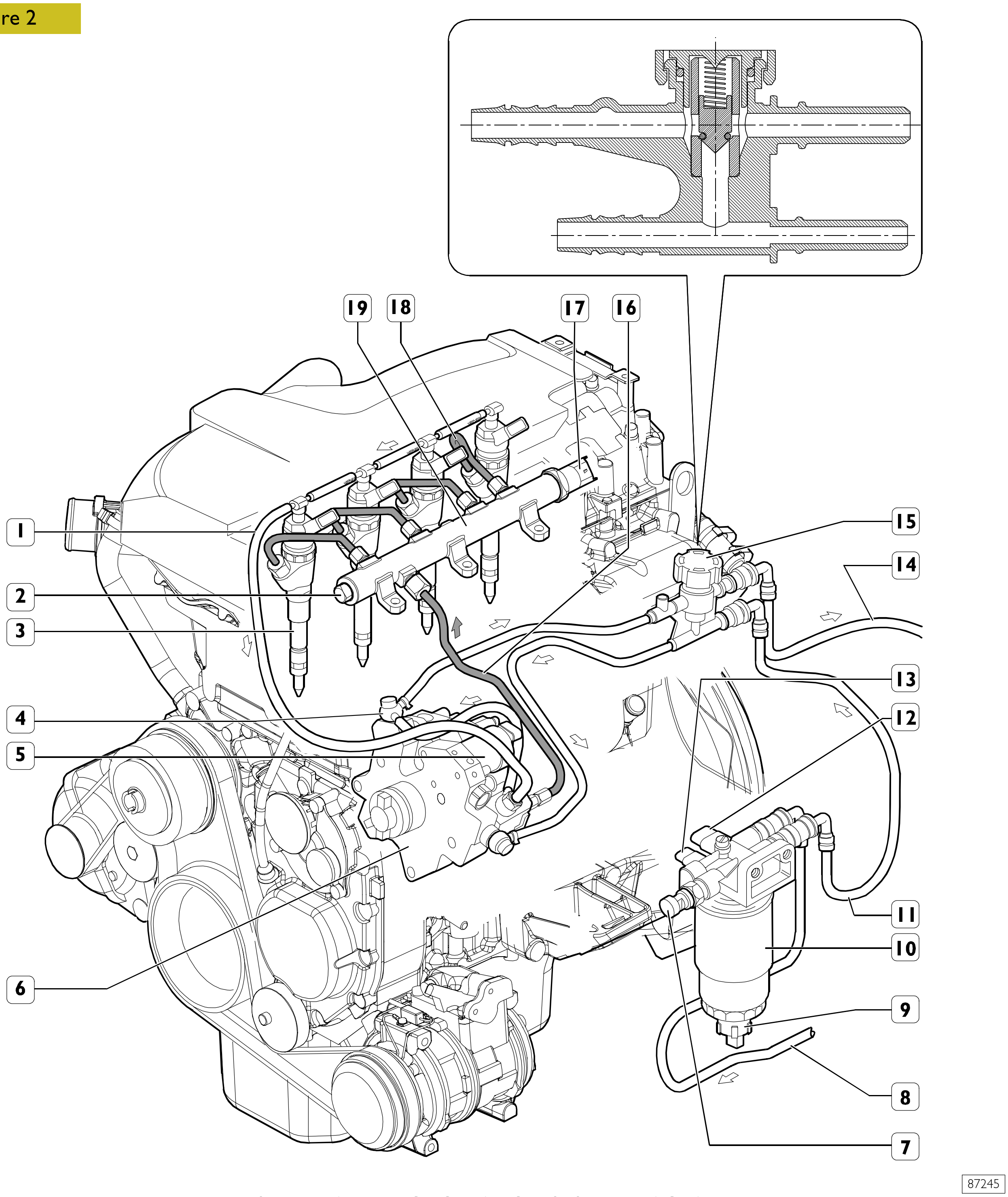
Figure 1



1. Fuel filter mounting - 2. High-pressure pump supply pipe quick-coupling fitting – 3. Supply pipe quick-coupling fitting.

If disconnecting the fuel pipes (2-3) from the mounting (1), it is necessary, when refitting, to make sure their fittings are perfectly clean. This is to avoid an imperfect seal and fuel getting out.

Figure 2



FUEL SUPPLY AND RECIRCULATION SYSTEM DIAGRAM

1. Injector fuel exhaust pipe - 2. Plug - 3. Electric injector - 4. Multiple pipe union - 5. Pressure regulator - 6. High pressure pump CP3.2 with built-in feeding pump- 7. Fuel delivery pipe to high pressure pump - 8. Sensor for water presence in the fuel filter - 9. Fuel filter - 10. Fuel return pipe to the filter - 11. Fuel inlet pipe from the reservoir - 12. Temperature sensor connector - 13. Fuel return pipe to the reservoir - 14. Fuel filter clogged sensor - 15. Non-return valve - 16. High pressure fuel delivery pipe to the hydraulic accumulator (rail) - 17. Pressure sensor - 18. High pressure fuel delivery pipe to the electric injectors - 19. Hydraulic accumulator (rail).

Check valve characteristics

opening pressure $0.5^{+0.05}_{-0.1}$ bar

differential pressure less than 0.2 bar at 120 litres/h of fuel.

(grey)	High pressure fuel pipes
(white)	Low pressure fuel recirculation pipes

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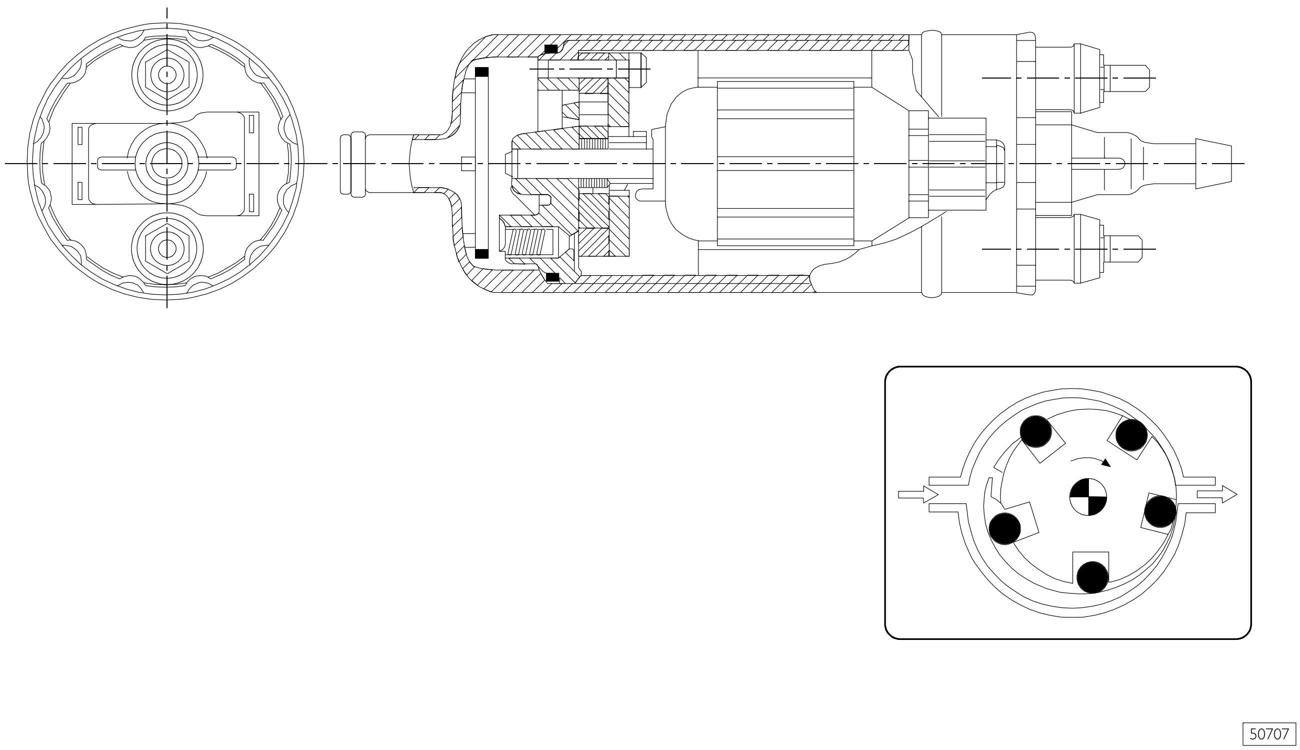
Fuel pump

Figure 3



CROSS-SECTION OF FUEL PUMP

This rotary positive displacement pump with integrated by-pass is mounted on the suction pipe, on the left-hand side of the chassis frame.

The fuel pump is the roller-type with positive displacement, a brush motor with energizing by permanent magnets.
The impeller turns, driven by the motor, creating volumes that shift from the inlet port to the delivery port.
These volumes are defined by the rollers that stick to the outer ring when the motor turns.

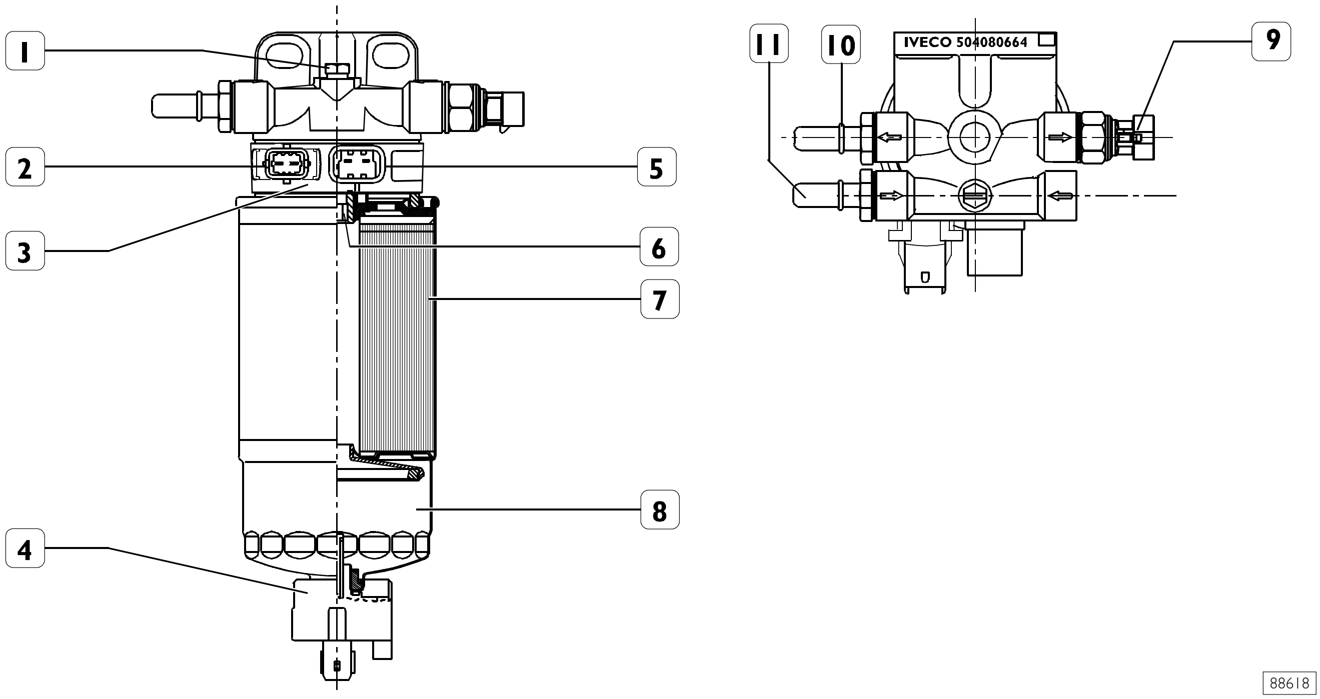
The pump has two valves, a check valve to prevent the fuel circuit from emptying (with the pump stationary) and an overpressure valve that recirculates the delivery with the inlet when pressures over 5 bar are produced.

Specifications

Delivery pressure:	2.5 bar
Flow rate:	> 155 litres/h
Power supply:	13.5 V - < 5 A
Coil resistance at 20°C:	28.5 Ohms

Fuel filter

Figure 4



1. Bleeding screw - 2. Temperature sensor connector - 3. Heater support - 4. Water presence sensor - 5. Heater connector - 6. Threaded insert - 7. Fuel filter - 8. Water separator - 9. Filter clogged sensor - 10. Connector - 11. Connector.

The fuel filter screwed on the heater support (3) consists of a cartridge (6) fitted with water sensor (7).
The water accumulation capacity (A) of the filter is approx. 100 cm^3.
The water indicator (4) is mounted on the bottom end. Unscrewing the indicator (4) drains off any water.
The heater support (3) has the temperature sensor built-in (9).
A clogging warning sensor (9) is screwed on the support (3).
When the temperature of the diesel is less than 6°C, an electric heating element warms it up to at most 15°C before sending it to the high pressure pump.

Clogging indicator characteristics

differential working pressure	1.1 bar

Tightening torques

1.	Bleed screw	4 Nm
4.	Water indicator	0.8±1.2 Nm
6.	Insert	30±2 Nm
7.	Fuel filter tightening	18±2 Nm
9.	Tightening of clog sensor	20±2 Nm
10.	Connector	35±2 Nm
11.	Connector	35±2 Nm

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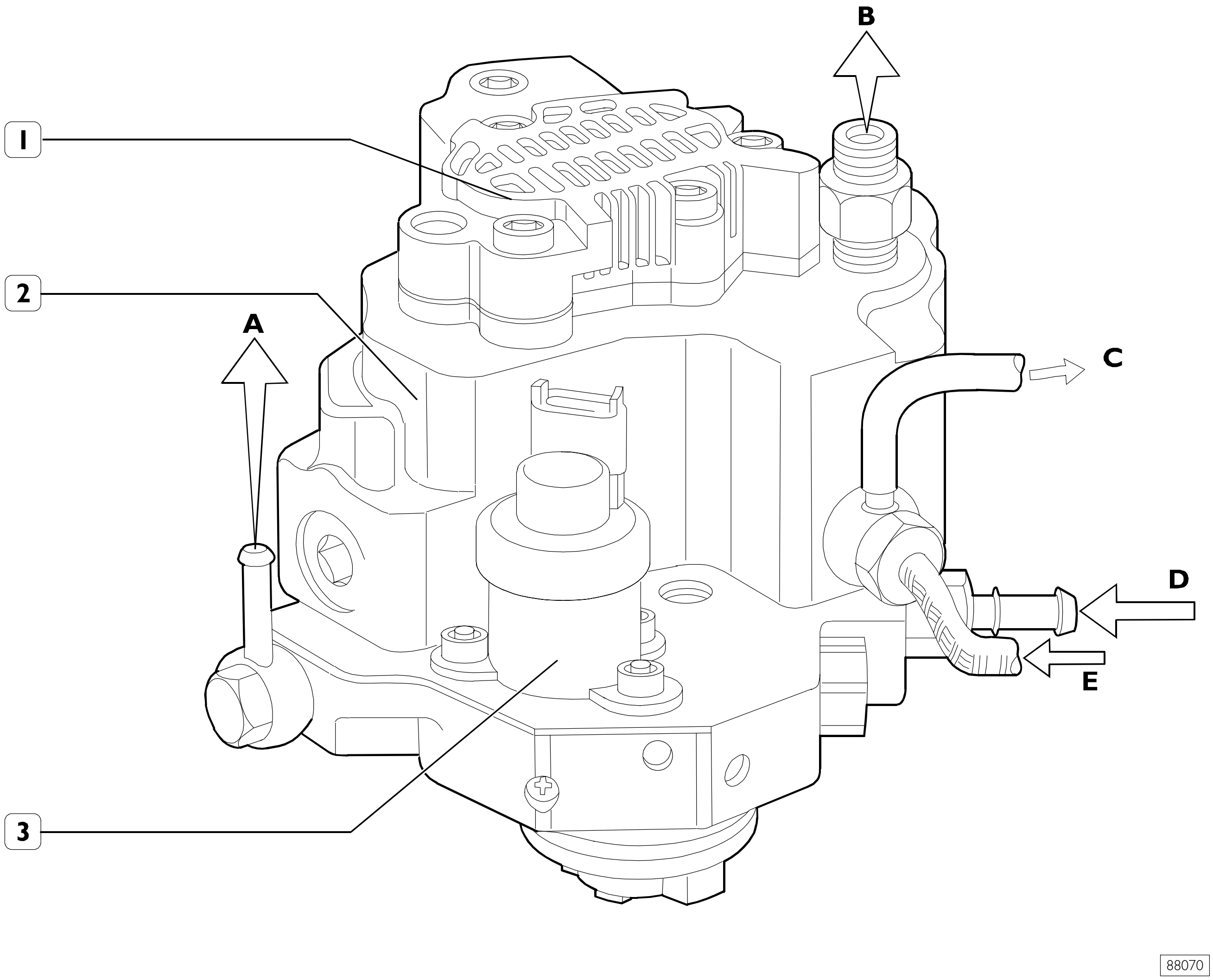
High-pressure pump

Figure 5

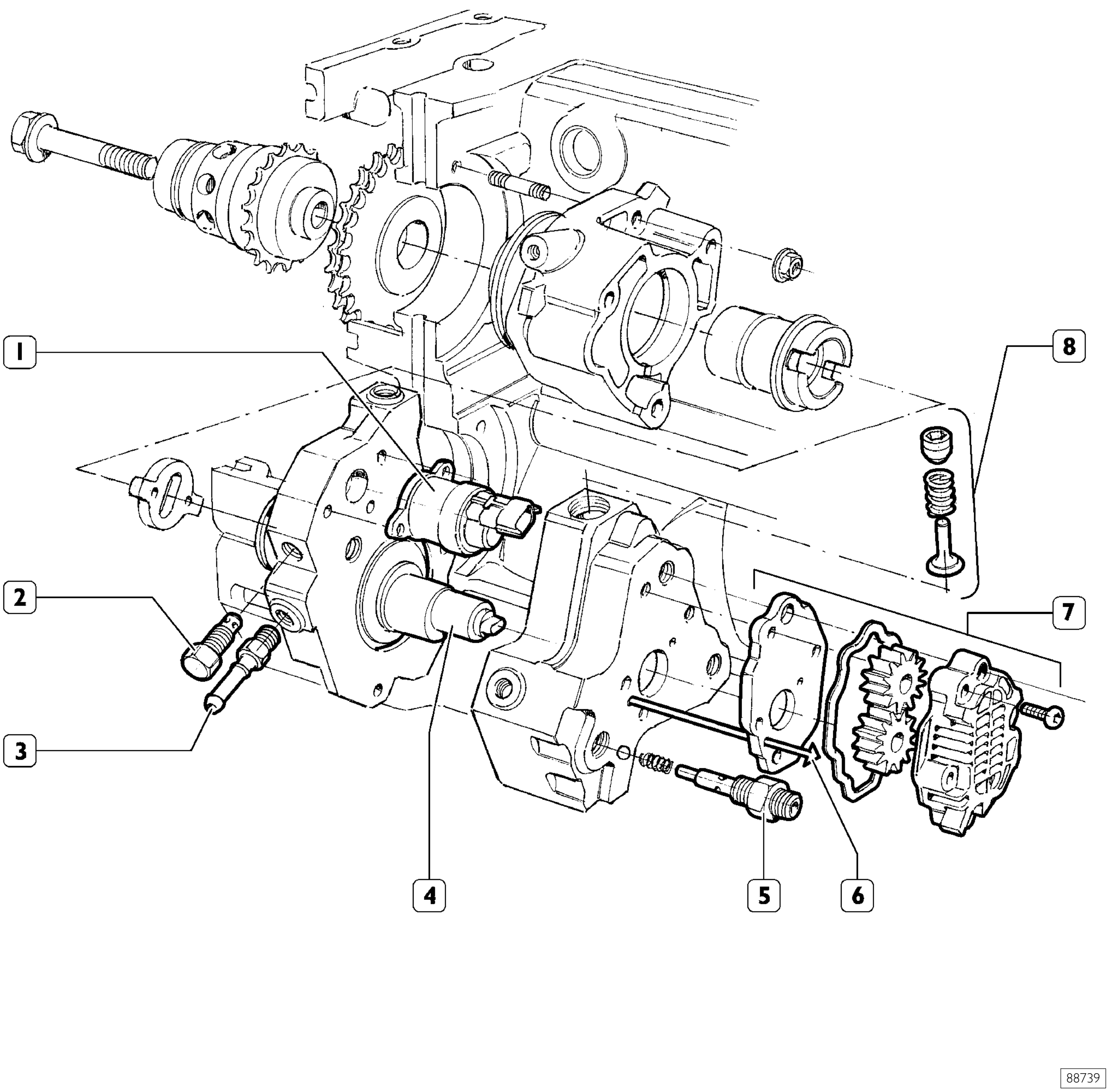


1. Feed mechanical pump - 2. High pressure pump CP3 - 3. Pressure regulator
A. Return to reservoir - B. Delivery to hydraulic accumulator (Rail) - C. Fuel inlet pipe from the filter - D. Return from injectors - E. Return from hydraulic accumulator (Rail).

Pump with 3 radial pumping elements controlled via a gear by the timing belt; it needs no timing. On the rear of the high-pressure pump there is the mechanical supply pump, controlled by the shaft of the high-pressure pump.
The pump is lubricated and cooled by the fuel.

NOTE The high-pressure pump – supply pump assembly cannot be overhauled and therefore the fixing screws must be neither removed nor tampered with. The only permissible job is replacing the driving gear.

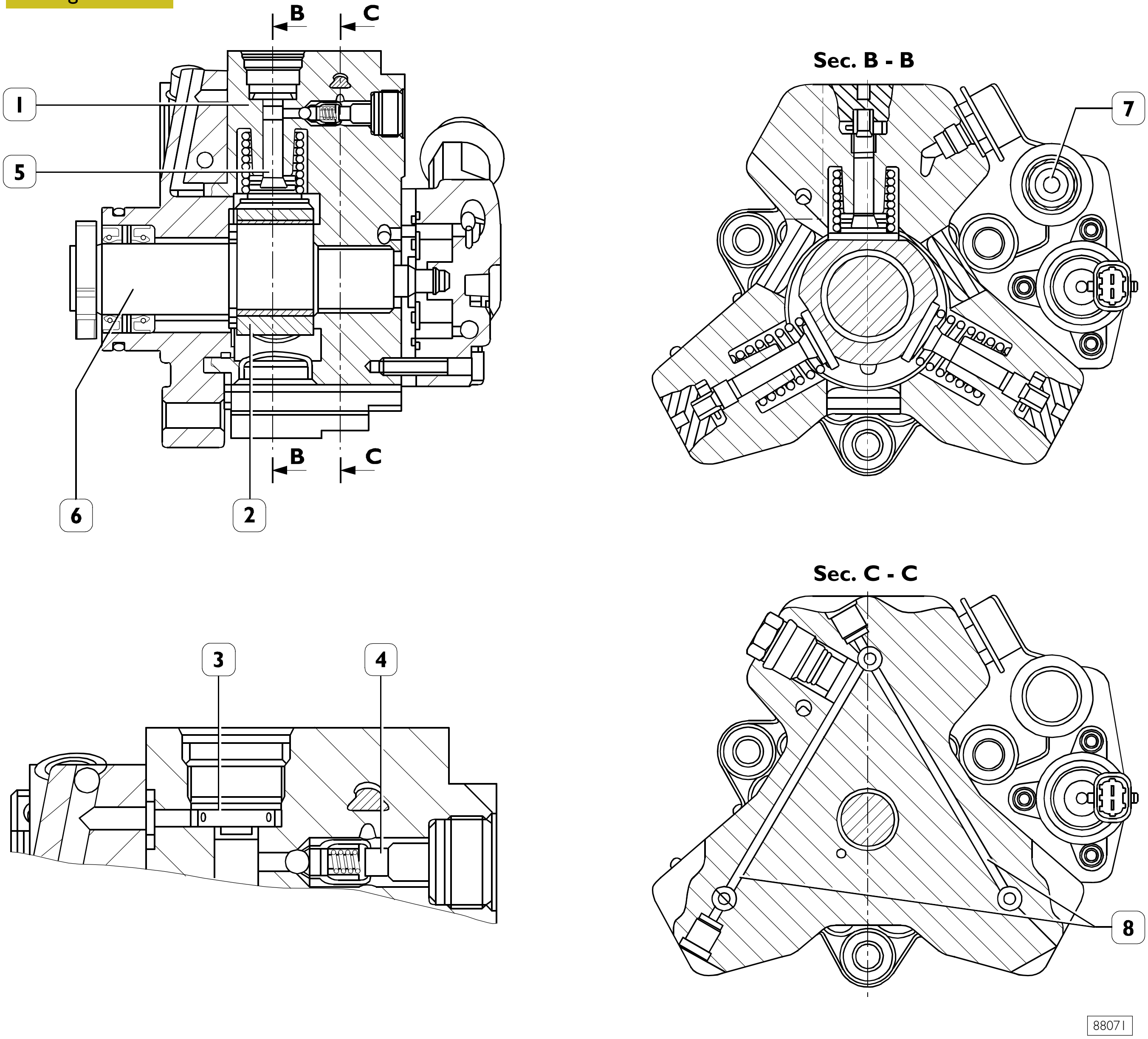
Figure 6



1. Pressure regulator - 2. Modulating valve 5 bar - 3. Fuel filler from the filter - 4. Pump shaft - 5. Delivery valve to hydraulic accumulator (rail) - 6. Fuel return from high pressure pump - 7. Feed mechanical pump - 8. Delivery valve on single pumping element.

High-pressure pump internal structure

Figure 7



1. Cylinder – 2. Three-lobed element – 3. Plate intake valve – 4. Ball delivery valve – 5. Plunger – 6. Pump shaft – 7. Low-pressure fuel inlet – 8. Fuel ducts to supply pumping elements.

Each pumping assembly comprises:

- a plunger (5) operated by a three-lobed element (2) floating on the shaft of the pump (6). Since the element (2) floats on a misaligned portion of the shaft (6), during shaft rotation, it does not turn with it but is only shifted in a circular movement on a wider radius, with the result of working the three pumping elements alternately:
- a plate intake valve (3);
- a ball delivery valve (4).

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Working principle

Figure 8

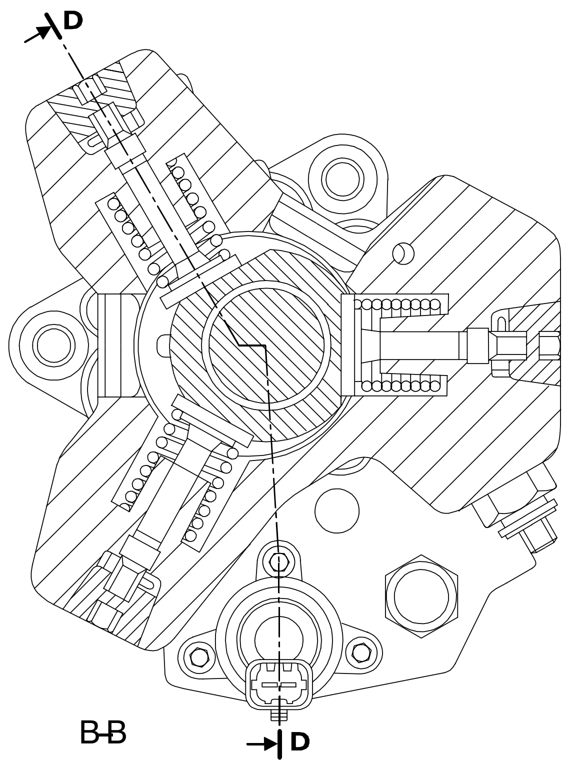
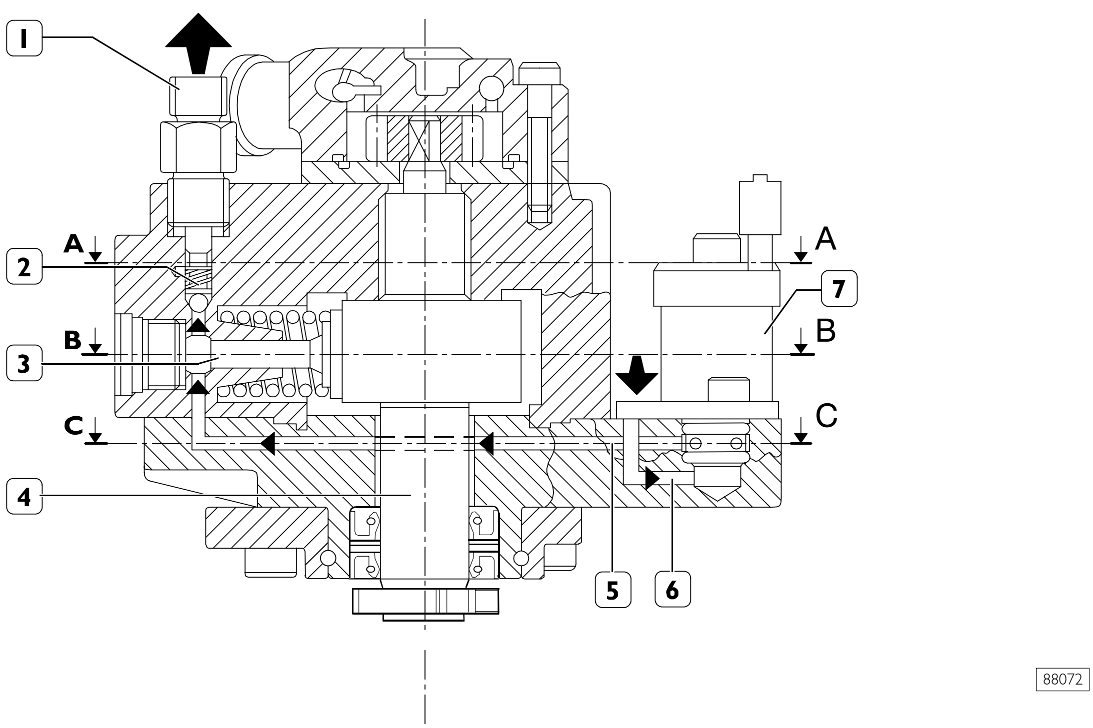


Figure 9

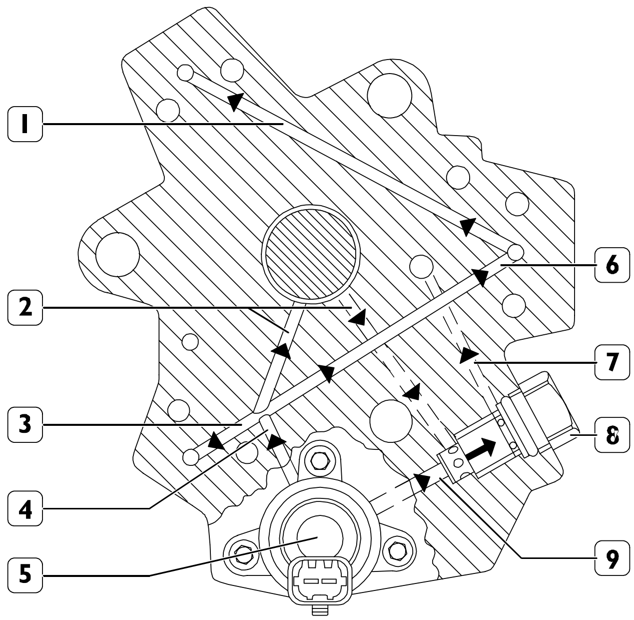


Sec. D - D

1. Outlet for delivery to rail – 2. Delivery valve to rail – 3. Pumping element – 4. Pump shaft – 5. Pumping element supply duct – 6. Pressure regulator supply duct – 7. Pressure regulator.

The pumping element (3) is arranged on the cam on the pump shaft. In the suction phase, the pumping element is supplied through the supply duct (5). The amount of fuel to send to the pumping element is determined by the pressure regulator (7). The pressure regulator, on the basis of the PWM command received from the control unit, chokes the flow of fuel to the pumping element. During the compression phase of the pumping element, the fuel, on reaching such a pressure as to open the delivery valve to the common rail (2), supplies it through the outlet (1).

Figure 10



Sec. C - C (Figure 9)

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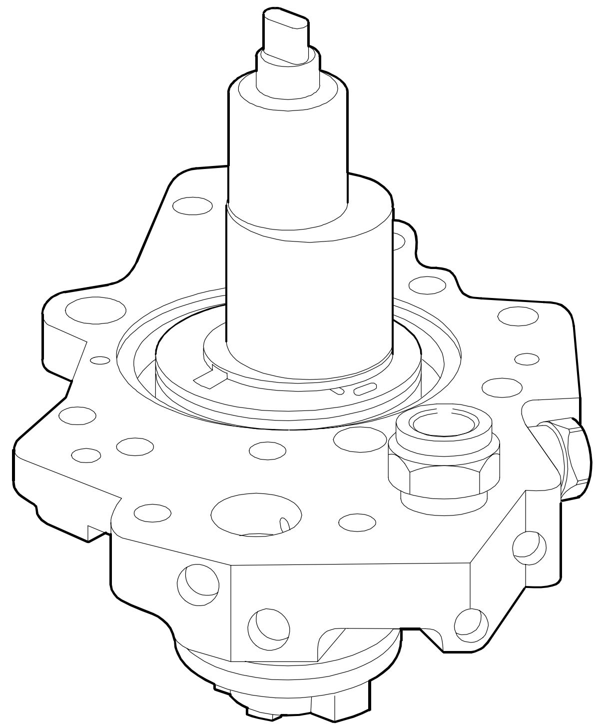

88073

1, 3, 6 Pumping element inlet – 2. Pump lubrication ducts – 4. Main pumping element supply duct – 5. Pressure regulator – 7. Regulator outlet duct – 8. Relief valve 5 bar – 9. Fuel outlet from regulator inlet.

Figure 10 shows the low-pressure fuel routing in the pump; it highlights the main supply duct of the pumping elements (4), the supply ducts of the pumping elements (1-3-6), the ducts used to lubricate the pump (2), the pressure regulator (5), the 5-bar relief valve (8) and the fuel outlet.

The pump shaft is lubricated by the fuel through the delivery and return ducts (2).

The pressure regulator (5) determines the amount of fuel with which to supply the pumping elements; excess fuel flows out through the duct (9).

The 5-bar relief valve, besides acting as a manifold for the fuel outlets, has the function of keeping the pressure constant at 5 bars at the regulator inlet.

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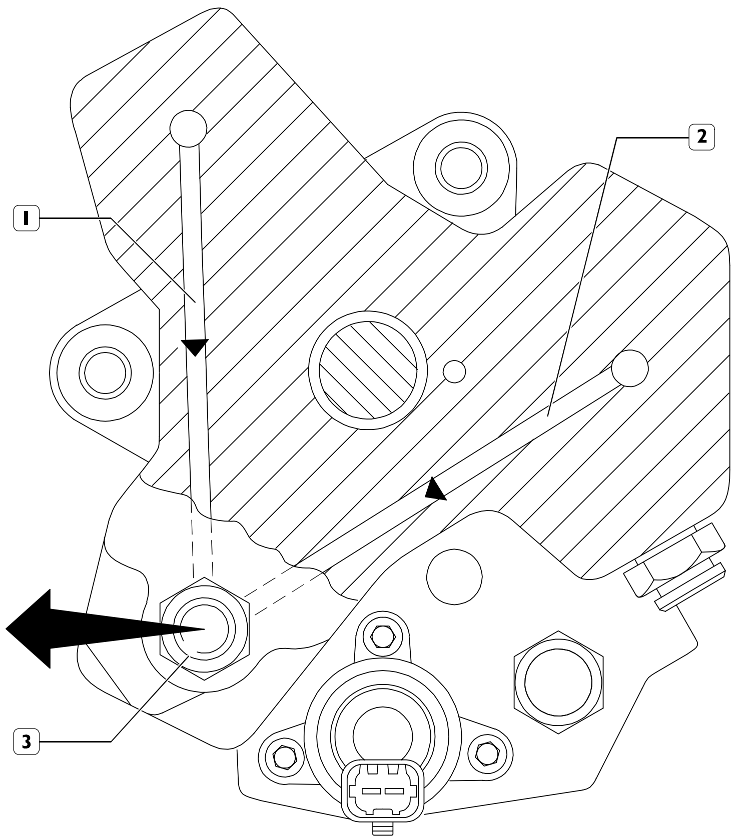
Figure 11



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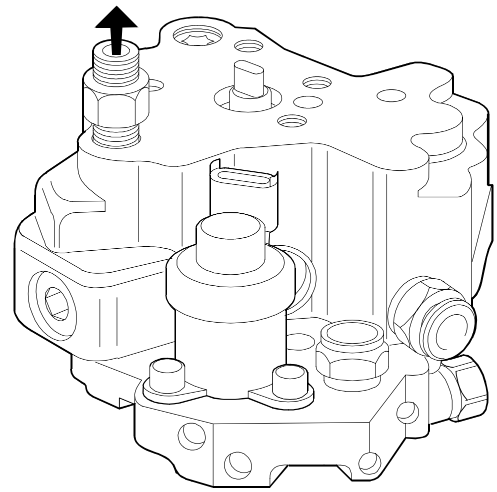

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Sec. A - A (Figure 9)

1, 2 Fuel outlet ducts – 3. Fuel outlet from the pump with coupling for high-pressure pipe for the common rail.

The figure shows the high-pressure fuel flow through the outlet ducts of the pumping elements.

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Pressure control valve

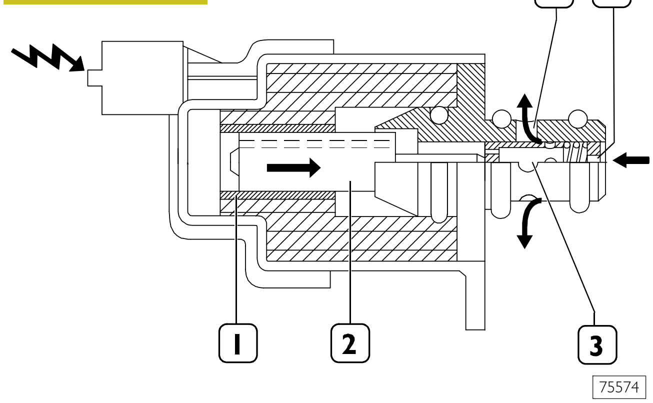
The fuel pressure regulator is mounted on the low-pressure circuit of the CP3 pump. The pressure regulator modulates the amount of fuel sent to the high-pressure circuit according to the commands received directly from the engine control unit. The pressure regulator is mainly composed of the following components:

- connector
- casing
- solenoid
- pre-load spring
- shutter cylinder.

When there is no signal, the pressure regulator is normally open, therefore with the pump providing maximum delivery. The engine control unit, via the PWM (Pulse Width Modulation) signal, modulates the change in fuel flow rate in the high-pressure circuit by partially closing or opening the sections of passage of the fuel in the low-pressure circuit.

Operation

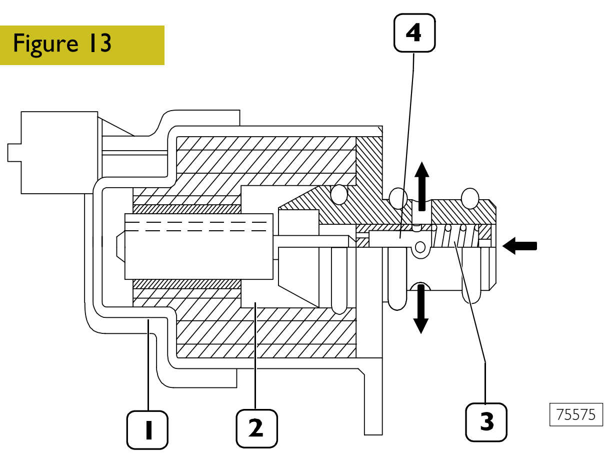
Figure 12



1. Solenoid – 2. Magnetic core – 3. Shutter cylinder – 4. Fuel inlet – 5. Fuel outlet.

When the engine control unit governs the pressure regulator (via PWM signal), the solenoid (1) is energized that, in its turn, generates the movement of the magnetic core (2). The shift of the core causes the shutter cylinder (3) to move axially, choking the flow of fuel.

Figure 13



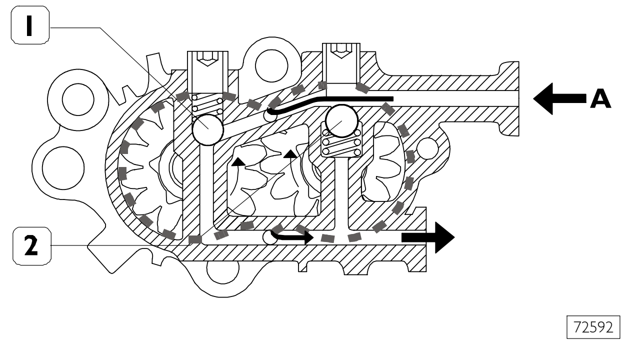
1. Solenoid – 2. Magnetic core – 3. Pre-load spring – 4. Shutter cylinder.

When the solenoid (1) is not energized, the magnetic core is pushed into the rest position by the pre-load spring (3). In this condition, the shutter cylinder (4) is in such a position as to offer the fuel the greatest section of passage.

MECHANICAL SUPPLY PUMP

Normal working condition

Figure 14



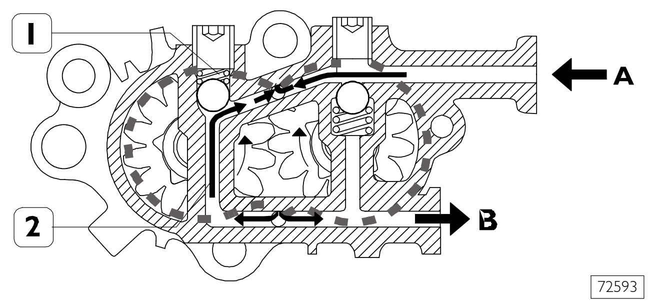
A. Fuel inlet from the tank – B. Fuel outlet to the filter – 1, 2 By-pass valves in closed position.

The function of the gear pump, mounted on the rear of the high-pressure pump, is to supply the high-pressure pump. It is governed by the shaft of the high-pressure pump.

In normal working conditions, the flow of fuel inside the mechanical pump is shown in the figure.

Conditions of outlet overpressure

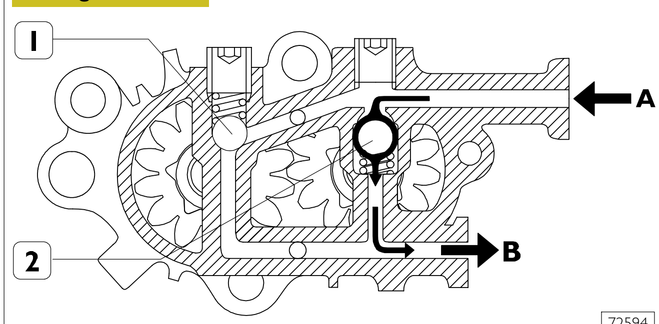
Figure 15



The by-pass valve (1) trips when overpressure is generated at the outlet B. The pressure, overcoming the elastic resistance of the spring of the valve (1), sets the outlet in communication with the inlet via the duct (2).

Conditions of bleeding

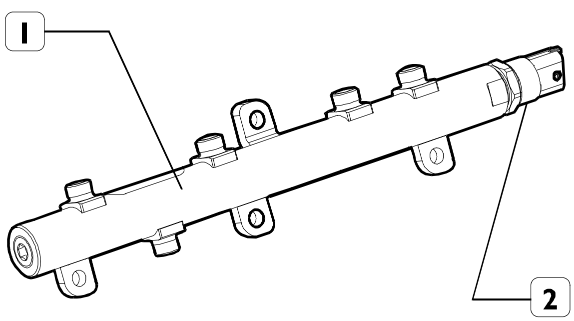
Figure 16



The by-pass valve (1) trips when, with the engine switched off, you want to fill the supply system via the priming pump. In this situation, the by-pass valve (2) opens, due to the effect of the inlet pressure, and the fuel flows out via the outlet B.

Hydraulic accumulator (rail)

Figure 17



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The hydraulic accumulator is fitted on the cylinder head on the suction side.

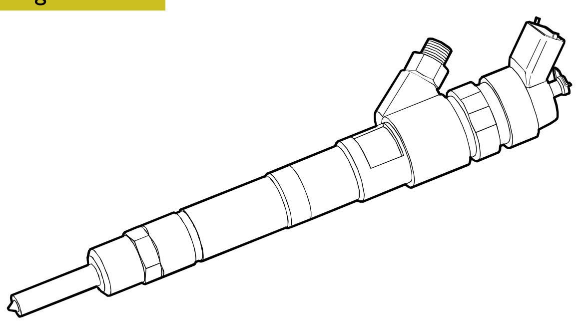
With its volume of approximately 23 cm^3 it dampens the pressure ripples of the fuel due to:

- the operation of the high-pressure pump;
- the opening of the electro-injectors.

On the hydraulic accumulator (1) there is the fuel pressure sensor (2).

ELECTRO-INJECTORS

Figure 18



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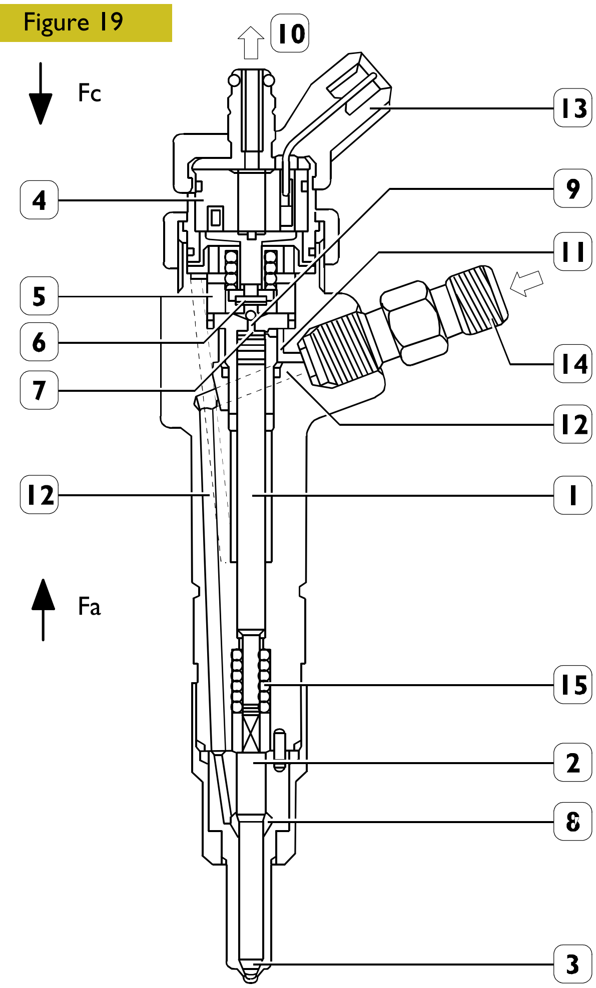
The electro-injectors have high-pressure supply (up to 1600 bar) and recirculation at atmospheric pressure, necessary for the diesel used to operate the pilot valve.
The temperature of the diesel put back into circulation by the electro-injector can get very high (approximately 120°C).
The head of the electro-injector has a fitting for the electrical connector.
They are mounted on the cylinder head and operated by the injection control unit.
The electric injector can be subdivided into two parts (see NO TAG):

The electro-injector can be divided into two parts:

- actuator/jet composed of pressure rod (1), pin (2) and nozzle (3);
- control solenoid valve composed of coil (4) and pilot valve (5).

Figure 19



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1 Pressure rod – 2 Pin – 3 Nozzle – 4 Coil – 5 Pilot valve – 6 Ball shutter – 7 Control area – 8. Pressure chamber - 9 Control volume – 10 Low-pressure fuel return – 11 Control pipe – 12. Feeding pipe - 13 Electrical connection – 14 High-pressure fuel inlet fitting – 15 Spring.

Operation

Electro-injector operation can be broken down into three phases:

- "rest position"

The coil (4) is de-energised and the shutter (6) is in closed position and does not allow the fuel to get in the cylinder, Fc > Fa (Fc: due to the fuel pressure operating the rod (1) control area (7). Fa: due to the line pressure operating in the pressure chamber (8).

- "start of injection"

The coil (4) is energized and causes the shutter (6) to rise. The fuel of the control volume (9) flows off towards the return manifold (10) causing a drop in pressure in the control area (7).
At the same time, the line pressure through the fuel pipe (12) exerts in the pressure chamber (8) a force equal to Fa > Fc and thus makes the pin (2) lift and so the fuel gets in the cylinders.

- "end of injection"

The coil (4) is de-energized and makes the shutter (6) return to its closed position. This recreates such a balance in the forces as to make the pin (2) return to its closed position and consequently end injection.

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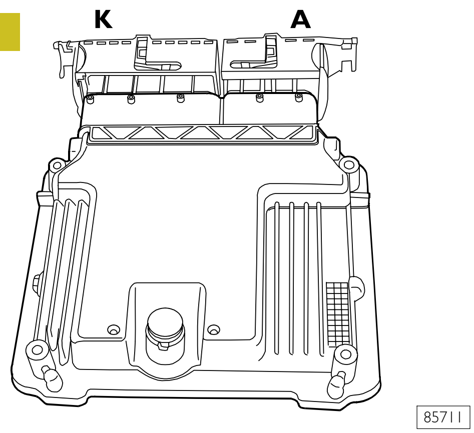
ELECTRIC/ELECTRONIC COMPONENTS

Electronic control unit EDC 16

Figure 20



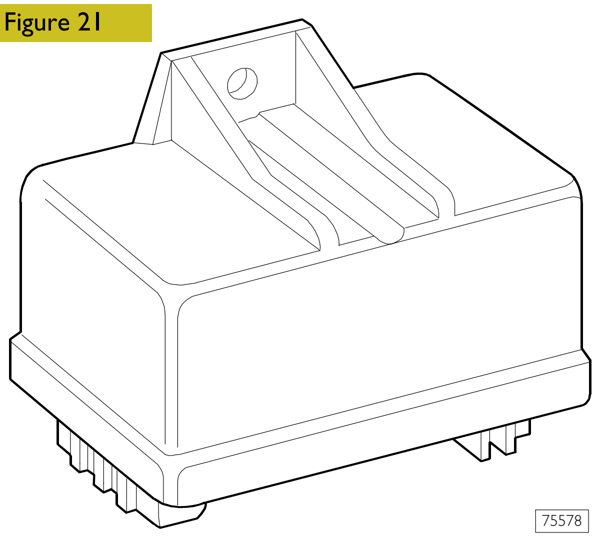
The control unit is a "flash EPROM" and so it can be reprogrammed from outside without changing the hardware. It processes the signals from the sensors by applying software algorithms and controls the actuators (especially the electro-injectors and pressure regulator).
The injection control unit has the absolute pressure sensor built in to further improve the control of the injection system.
The control unit is mounted on the left-hand side of the engine bay and is connected to the vehicle's wiring harness by two 60-pin connectors:

- 60-pin connector **A** for the components on the engine
- 94-pin connector **K** for the components on the vehicle

In addition to handling the operation of the system described under the relevant heading, the electronic control unit is interfaced with the other electronic systems on the vehicles such as ABS – EBD cruise control, speed limiting device, immobilizer (IVECO CODE), EGR and glow plugs.

Glow plug electronic control unit

Figure 21



The engine control unit, in the phase of:

- starting
- after-starting

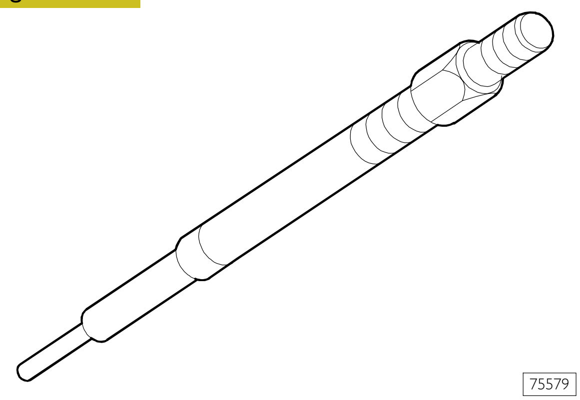
times the operation of the glow plug control unit according to the engine temperature.

The spark plug control takes place through the spark plug pre-warming control unit according to the engine temperature under the direct control of the engine control unit EDC 16.

The pre-heating control unit contains an "intelligent" contactor that sends feedback to the control unit that is thus informed about any fault with the pre-heating control unit or shorting to earth of the glow plugs.

Glow plugs

Figure 22



CONTROL VALUES

With a constant supply voltage of 11 V:

- max. current drawn	18 A
- in 5 sec.	11 ±1.5 A
- in 30 sec.	6 ±0.9 A
- temperature after 7 sec.	850°C
- tightening torque	8-10 Nm

Engine speed sensor

It is an inductive sensor and is positioned on the phonic wheel fitted on the front end of the drive shaft
It generates the signals resulting from the magnetic flow lines which close through the teeth of the phonic wheel.
Tooth number 58.
The electronic control unit uses this signal to measure the speed of rotation of the engine, its angular position and to operate the electronic rev counter.
If this signal fails the rev counter will not work.

Camshaft timing sensor

It is an inductive sensor and is positioned on the camshaft gear of the suction valves.
It generates the signals resulting from the magnetic flow lines which close through a slot on the gear itself.
The signal generated by this sensor is used by the electronic control unit as a redundant signal to measure the different engine speeds.

SECTION 3

Vehicle uses

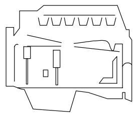
GENERAL SPECIFICATIONS

Type		**F1CE0481A*....**	**F1CE0481B*....**
Maximum power	kW (HP)	100 (136)	122 (166)
	rpm	3500	3500
Torque at 1000 rpm	Nm	240	250
Maximum torque	kW (HP)	340 (34.5)	380 (38.7)
	rpm	1400 ÷ 2800	1250 ÷ 3070
Slow running of engine with no load	rpm	800 ± 25	
Fast idling speed of engine with no load	rpm	4200 ± 50	
Pressure at T.D.C.	*bar	20 ÷ 26	
Minimum permissible pressure at T.D.C.	*bar	16	
Bore x stroke	mm	95.5 x 104	
Displacement	cm^3	2998	
TURBOCHARGING		With intercooler	
Turbocharger type		MITSUBISHI TD 04 - HL - 13T-6 con Waste-Gate	GARRETT GT 2260 V variable geometry
Turbocharger shaft radial play		0.396 ÷ 0.602	0.086 ÷ 0.117
Turbocharger shaft end float		0.034 ÷ 0.106	0.030 ÷ 0.083
Minimum stroke of pressure relief valve opening	mm	1	-
Maximum stroke of pressure relief valve opening	mm	5	-
Pressure corresponding to minimum stroke:	bar	1.21 ± 0.0026	-
Pressure corresponding to maximum stroke:	bar	1.45 ± 0.0039	-
LUBRICATION		forced by gear pump, pressure relief valve, oil filter with double filtering	
Oil pressure with engine hot (100°C ±5°C):			
at idling speed	bar	1.0	
at top speed	bar	5.0	
COOLING		by centrifugal pump, thermostat for adjustment, coolant temperature, fan with electromagnetic coupling, radiator, heat exchanger	
Water pump control:		by belt	
Thermostat:		N. I.	
start of opening:		79 °C ± 2 °C	
max opening:		94 °C ± 2 °C	

(*) The pressure is measured by setting the engine turning with the aid of just the starter motor, with an oil temperature of 40 – 50°C.

Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

	Type		F1CE0481A*....	F1CE0481B*....
	FLUIDS			
Urania Daily Urania LD 5	Quantity of oil for first filling	liters kg	7.6 5.81	
	Periodical replacement capacity	litres kg	7.6 6.79	

Data, features and performances are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Furthermore, the users assembled by the setter shall always be in conformance to couple, power and number of turns based on which the engine has been designed.

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PART ONE - MECHANICAL COMPONENTS

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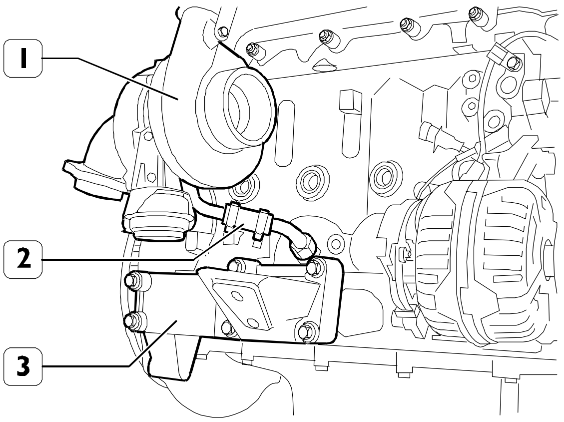
OVERHAULING ENGINE F1C DISASSEMBLING THE ENGINE AT THE BENCH

Figure 1



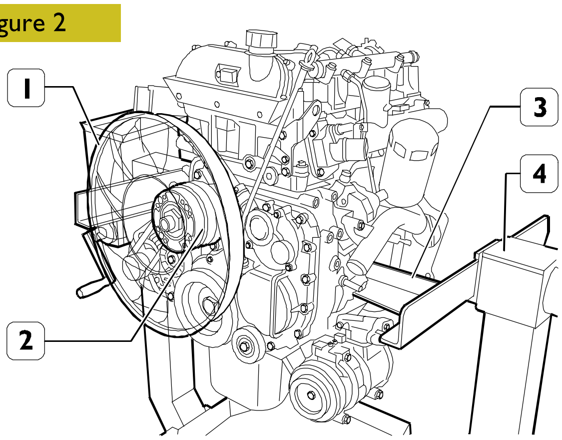
If the following parts have not already been removed, do so now:

- top soundproofing cover;
- rail guard;
- engine wire, by disconnecting its electrical connections from: thermostat temperature sensor, phase sensor, engine rev sensor, rail pressure sensor, air pressure/temperature sensor of suction manifold.

To be able to fit the brackets onto the crankcase to secure the engine to the stand for overhauling, it is necessary to remove the left and right engine mounts (3) and disconnect the oil pipe (2) from the turbocharger (1) and from the crankcase.

NOTE Block the turbocharger air/exhaust gas inlets and outlets to prevent foreign bodies getting inside.

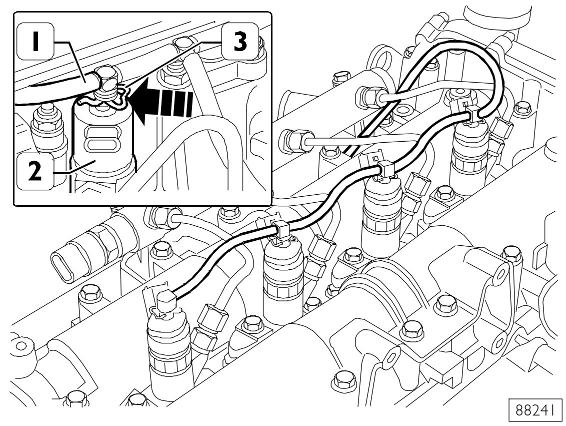
Figure 2



Fit the brackets 99361041 (3) to the crankcase and use these to secure the engine to the rotary stand 99322205 (4). Drain the oil from the engine by removing the plug from the oil sump.

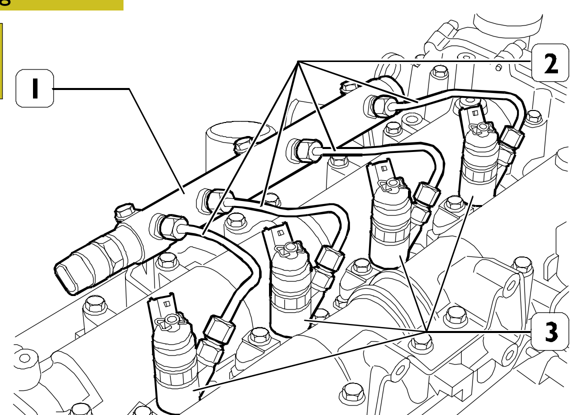
If fitted, remove the fan (1) from the electro-magnetic joint (2).

Figure 3



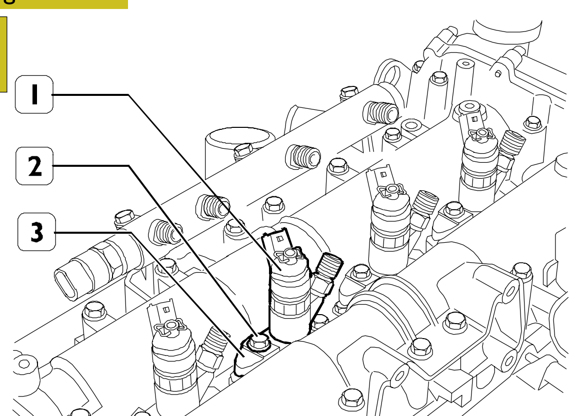
Press the springs (3) in the direction shown by the arrow and disconnect the fittings of the pipe (1) recovering fuel from the electro-injectors (2).

Figure 4



Disconnect the fuel pipes (2) from the electro-injectors (3) and from the hydraulic accumulator (1) (rail).

Figure 5



Take out the screws (2) and the brackets (3) fixing the electro-injectors (1) to the cylinder overhead.

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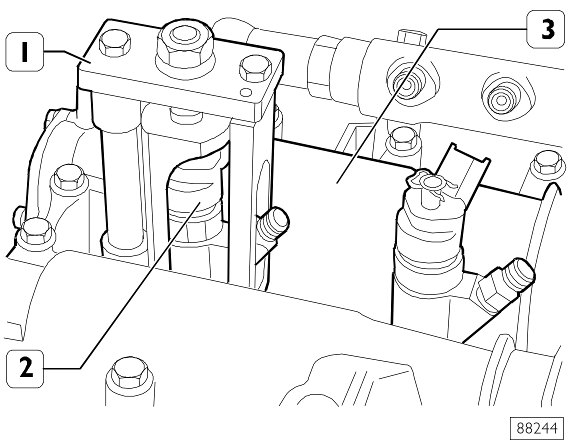
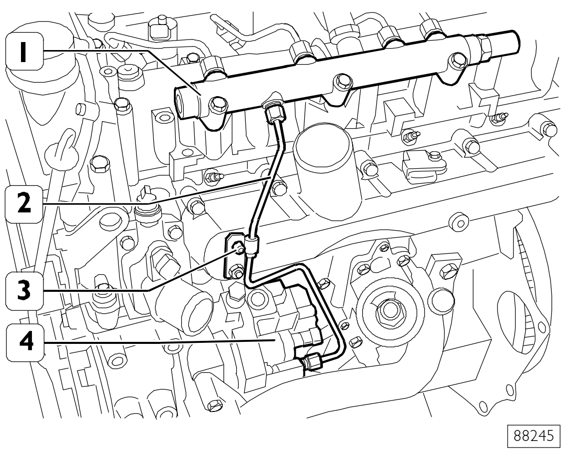
Figure 6



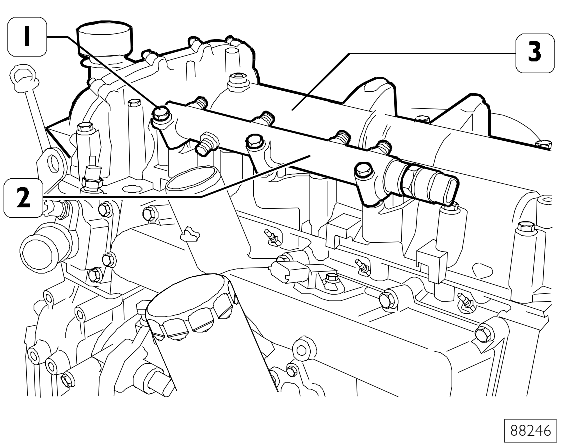
Using tool 99342153 (1) extract the electro-injectors (2) from the overhead (3).

Figure 7



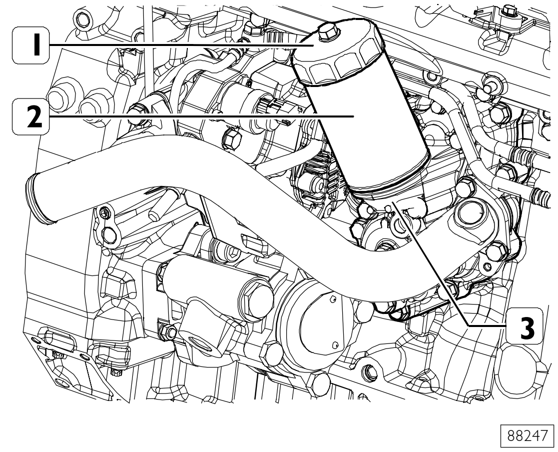
Remove the fastening screw (3) of the pipe retaining bracket (2). Disconnect the pipe (2) from the hydraulic accumulator (1) and the high pressure pump (4).

Figure 8



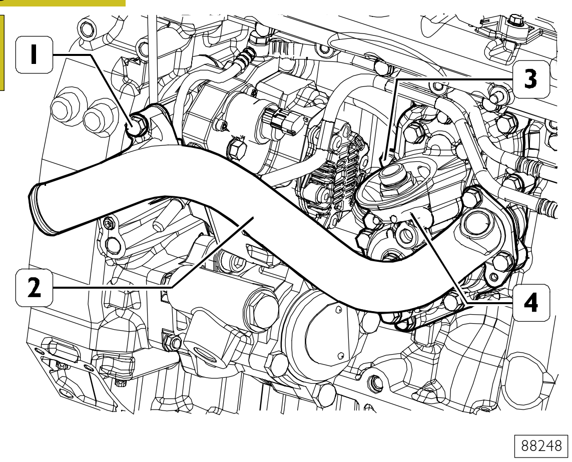
Remove the screws (1) and the hydraulic accumulator (2) from the overhead device (3).

Figure 9



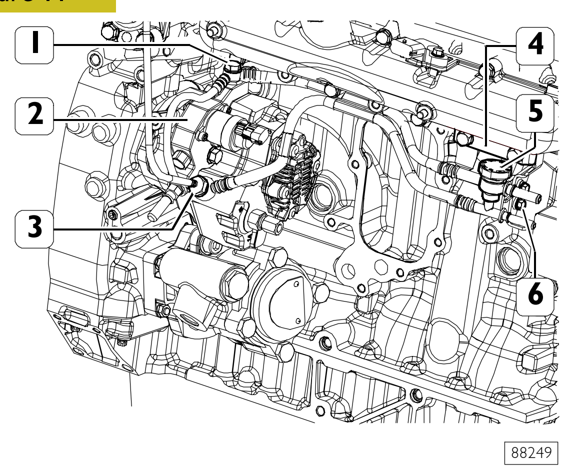
Use tool 99360076 (1) to remove the oil filter (2) from the heat exchanger (3).

Figure 10



Remove the screws (1 and 3) and the heat exchanger (4) with the relevant gasket and pipe (2).

Figure 11



Remove the screw (6) and the low pressure pipes (5) from the bracket (4).
Slacken the pipe unions (1 and 3) and remove the low pressure pipes (5) from the high pressure pump (2).

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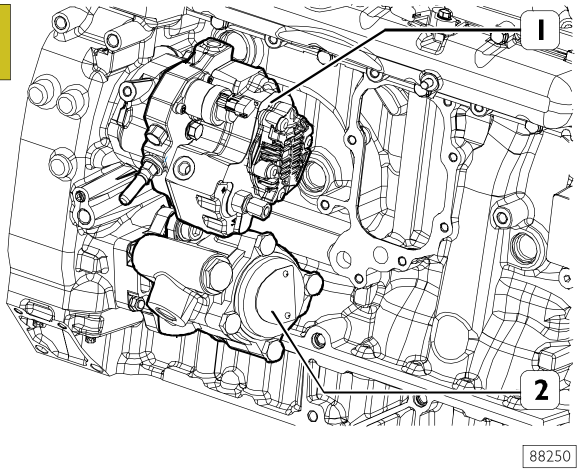
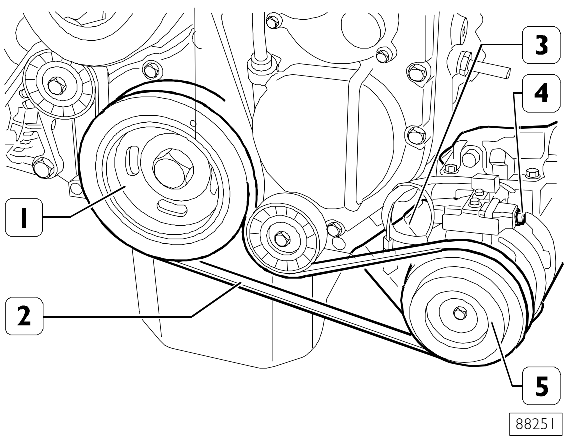
Figure 12



Remove the fastening screws and take off the high pressure pump (1) and the hydraulic power steering pump (2).

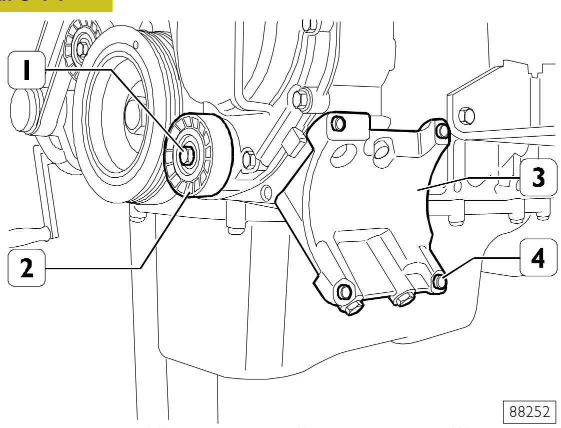
Figure 13



If fitted, use the suitable tool to remove the elastic belt (2) from the pulleys (1 and 5).
Remove the screws (4) and take off the climate control system compressor (3) from the support.

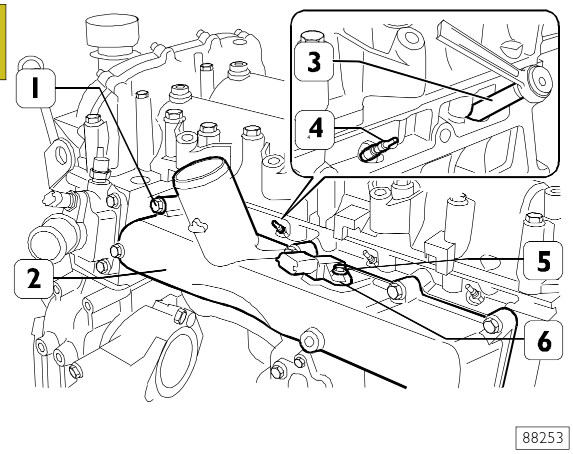
NOTE The elastic belt (2) must be changed at every removal.

Figure 14



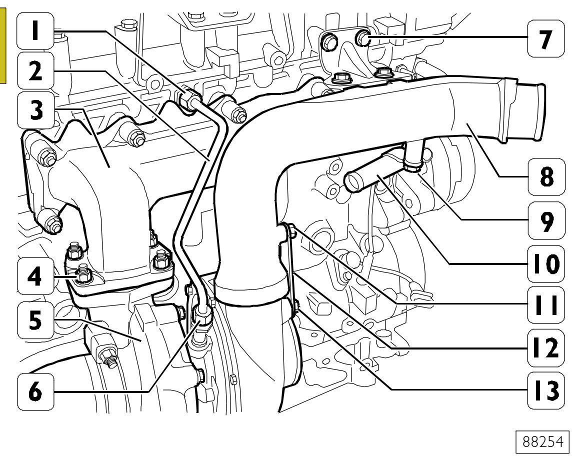
Remove the screws (4) and take off the support (3).
Remove the screw (1) and the fixed backstand (2).

Figure 15



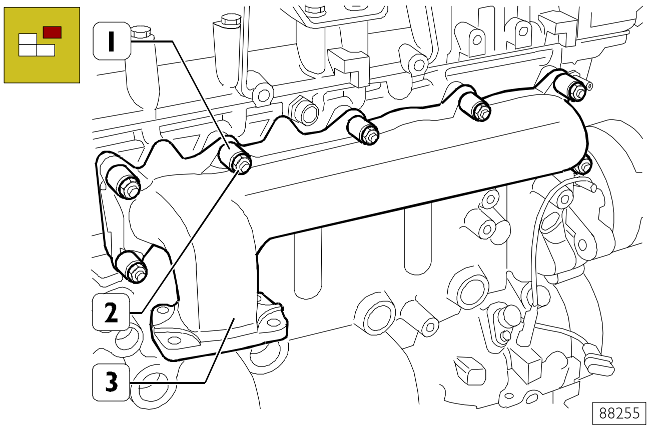
Remove the screw (5) and take off the air temperature and pressure sensor (6).
Remove the screws (1) and take off the suction manifold (2) with the relevant gasket.
Using wrench SP.2275 (3), remove the glow plugs (4).

Figure 16



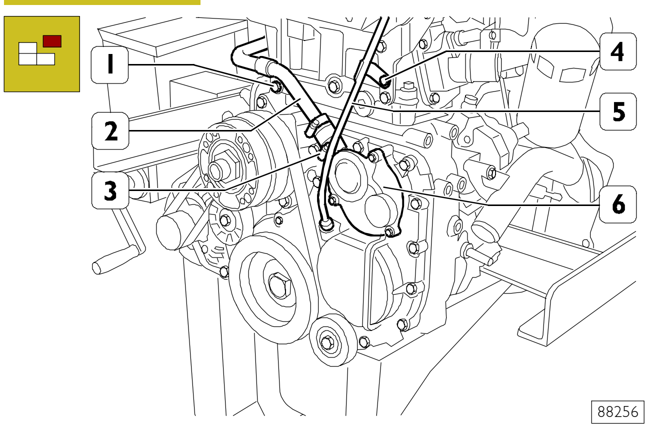
Slacken the pipe unions (1 and 6) and take off the oil pipe (2).
Remove the screws (11 and 13) and the bracket (12).
Remove the screw (9) fastening the pipe (10) to the inlet (8).
Remove the screws (7) and take off the inlet (8) from the turbocharger (5).
Remove the nuts (4) and take off the turbocharger (5) with the relevant gasket from the exhaust manifold (3).

Figure 17



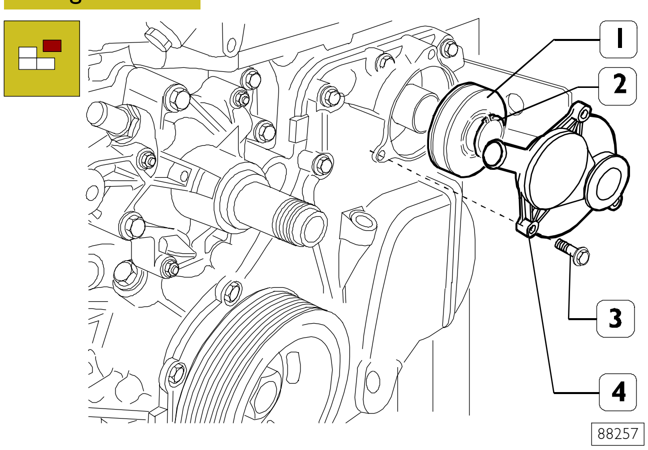
Remove the nuts (2), the spacers (1) and take off the exhaust manifold (3) with the relevant gasket from the cylinder head.

Figure 18



Remove the screw (4) and take off the pipe (5) of the oil level dip rod.
Slacken the clamp (3), remove the screw (1) and the pipe (2) from the cover (6).

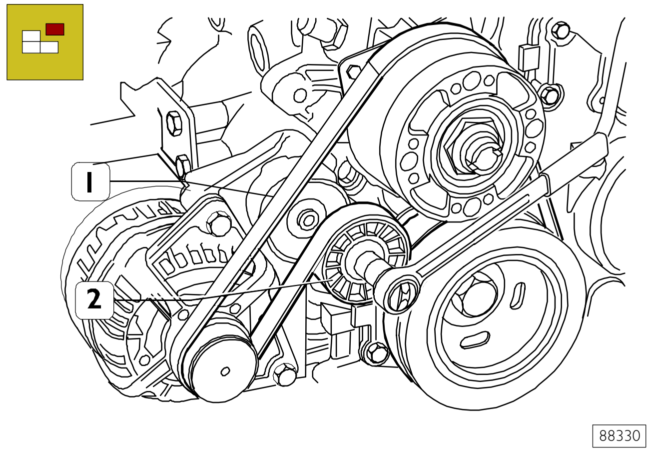
Figure 19



Remove the screws (3) and the cover (4). Take off the snap ring (2). Pull out the centrifugal filter (1).

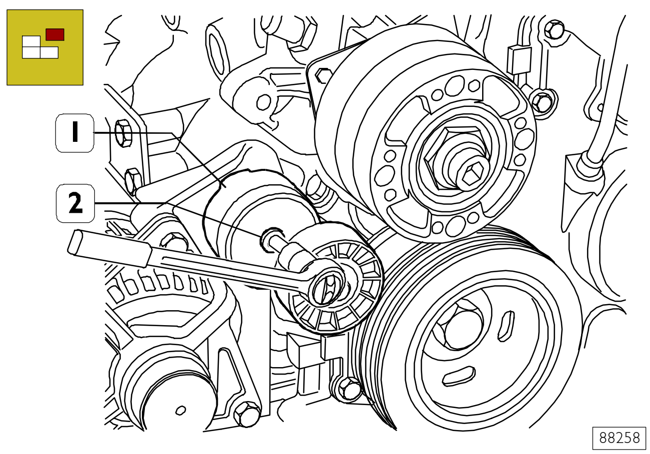
NOTE The centrifugal filter (1) and the seal ring of the cover (4) must be changed at every removal.

Figure 20



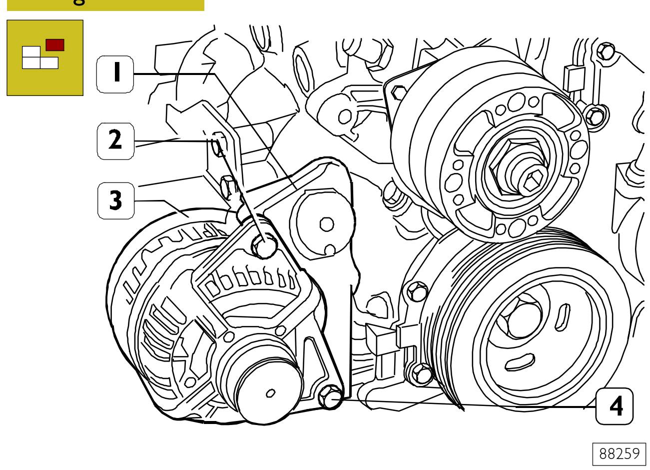
Using the specific wrench on the automatic tightener (2), slacken the tension of the belt (1) and remove it.

Figure 21



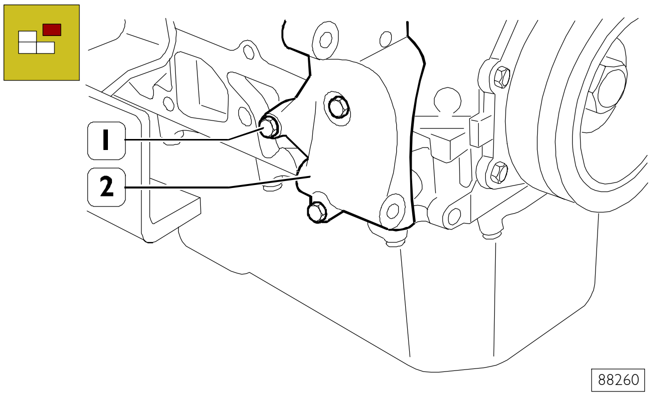
Take out the screw (2) and remove the automatic tightener (1).

Figure 22



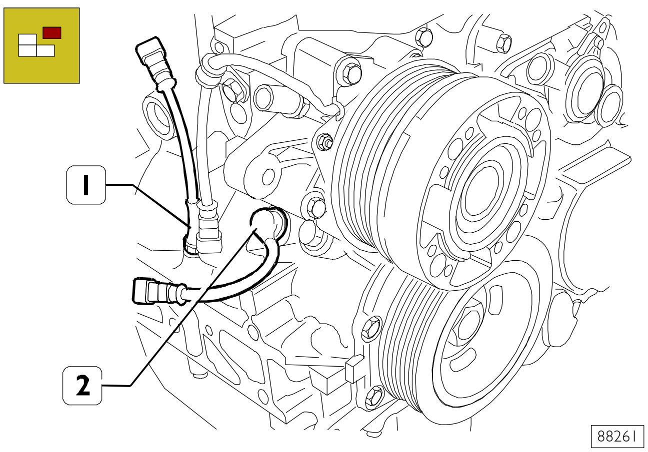
Remove the screw (2), the bolt (4) and pull the alternator (3) out of the support (1).

Figure 23



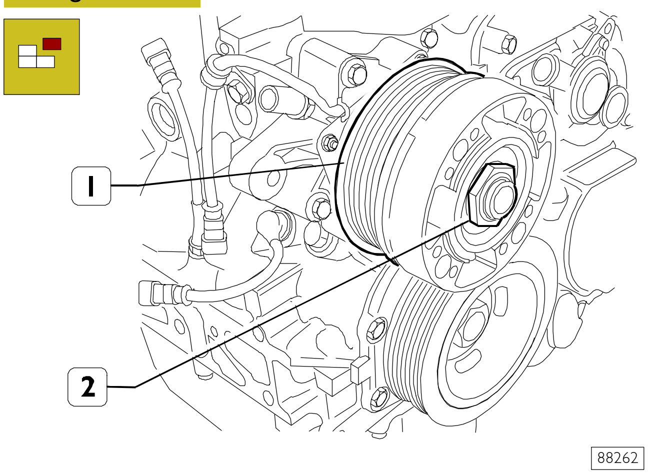
Remove the screws (1) and take off the support (2) from the cylinder block.

Figure 24



Use the suitable wrench to remove the oil level sensor (1). Remove the fastening screw and the rev sensor (2).

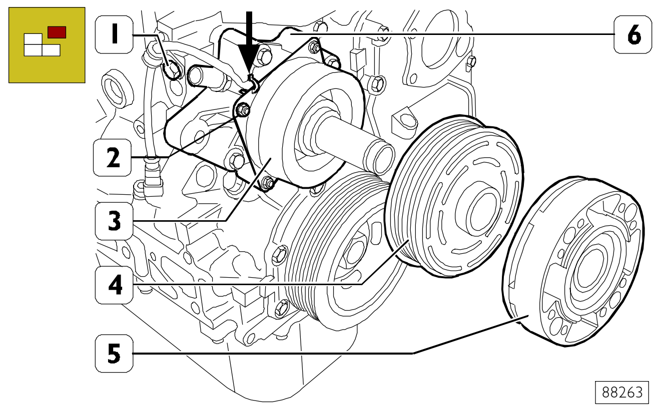
Figure 25



Stop the rotation of the electro-magnetic joint (1) and remove the nut (2).

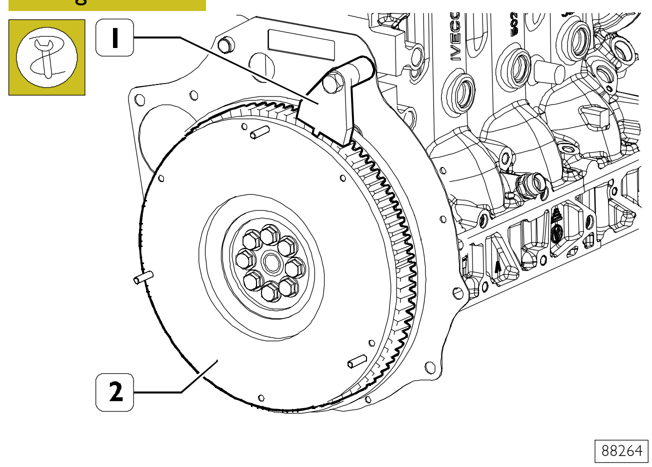
NOTE Slacken the nut (2) anticlockwise because its threading is left-handed.

Figure 26



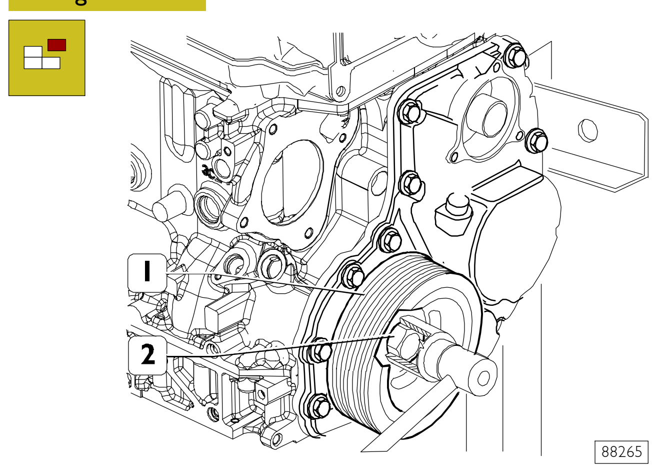
If there is an electromagnetic pulley, remove the hub (5) and the pulleys (4).
Cut the clamp (→), remove the fastening screw (1) of the wire clamp, the nuts (2) and take off the electric magnet (3) from the water pump (6).

Figure 27



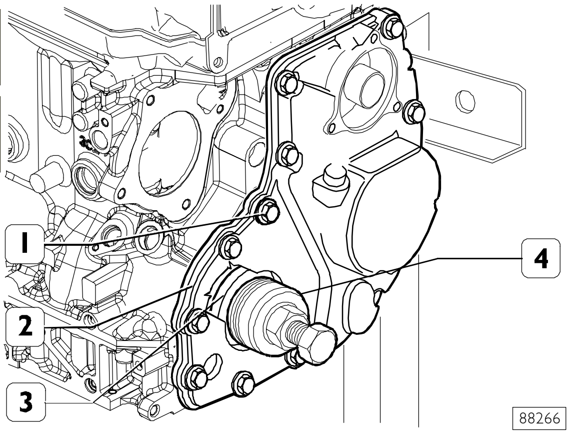
Stop the rotation of the engine flywheel (2) by means of tool 99360306 (1).

Figure 28



Remove the screw (2) and the damper pulley (1).

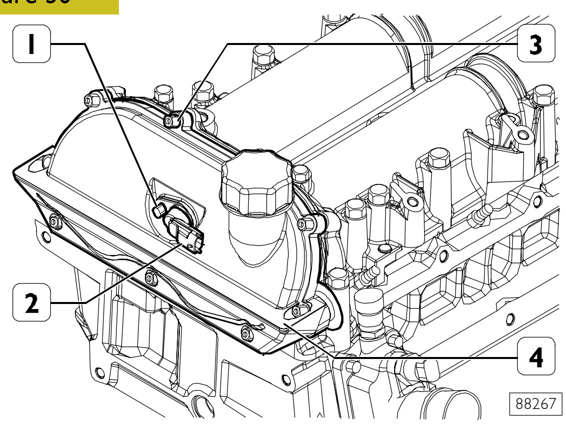
Figure 29



Remove the screws (1) and the distribution cover (2).

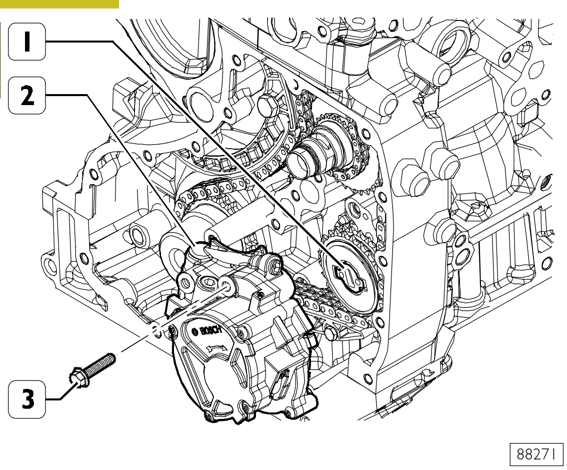
NOTE Tool 99340059 (4) is used to remove the seal ring (3) from the cover (2) when the engine is installed on the vehicle.

Figure 30



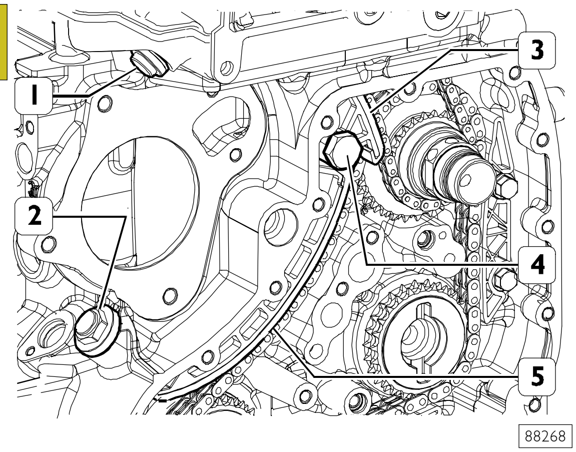
Remove the nut (1) and the phase sensor (2).
Remove the nuts (3) and the cover (4).

Figure 31



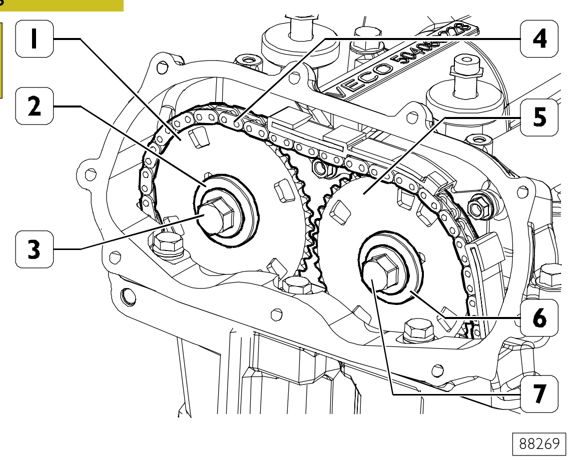
Remove the screws (3) and disassemble the depressor/oil pump unit (2).
Remove the connection key (1).

Figure 32



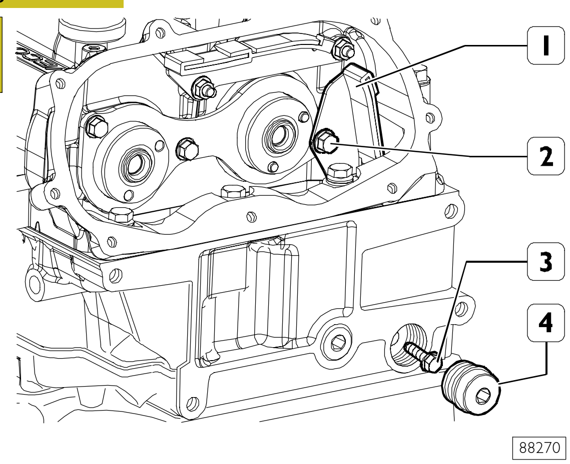
Remove the hydraulic chain tightener: top (1) and lower (2). Remove the pin (4) and disassemble the mobile skid: lower (5) and top (3).

Figure 33



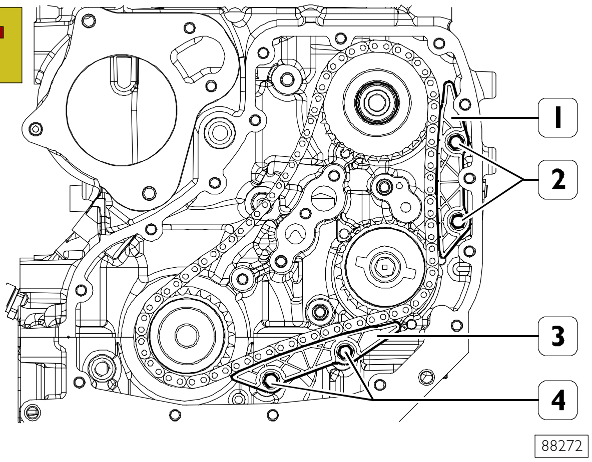
Remove the screw (3), the washer (2) and the gear (1). Remove the screw (7), the washer (6), the gear (5) and the chain (4).

Figure 34



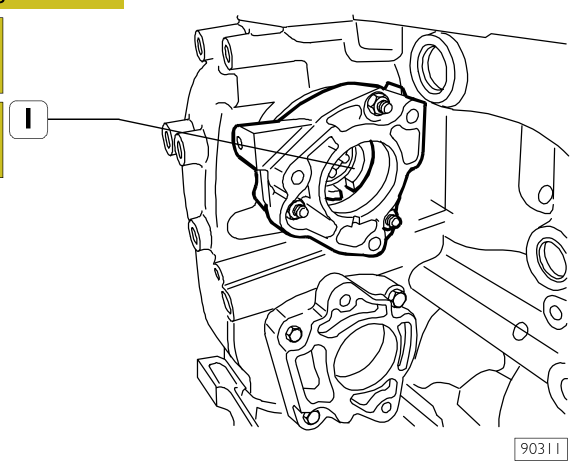
Remove the cap (4), the screws (2 and 3) and the top fixed skid (1).

Figure 35



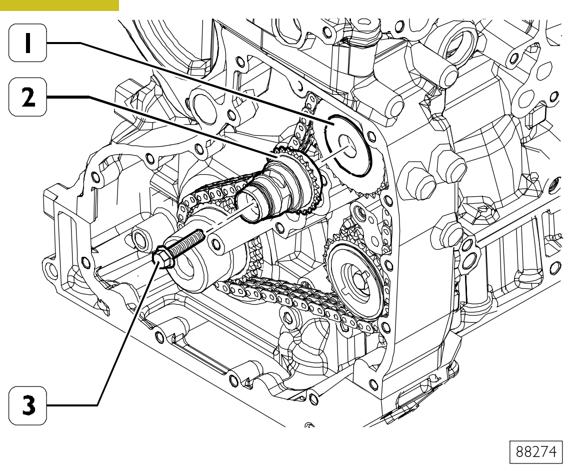
Remove the screws (2) and the side fixed skid (1).
Remove the screws (4) and the lower fixed skid (3).

Figure 36



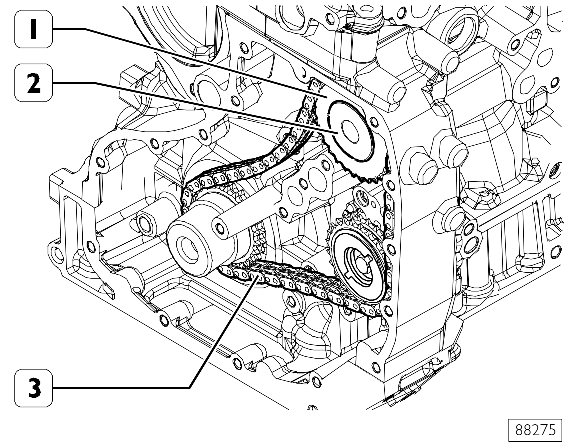
Stop the rotation of the high pressure pump control shaft (1) by inserting the suitable wrench inside it.

Figure 37



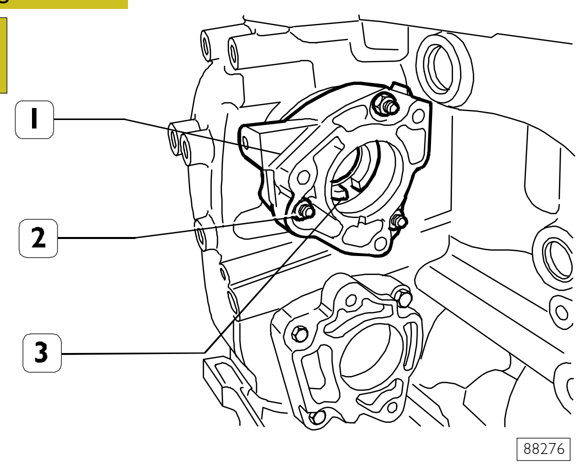
Remove the screw (3) and the stem with the drive gear (2) from the high pressure pump control shaft (1).

Figure 38



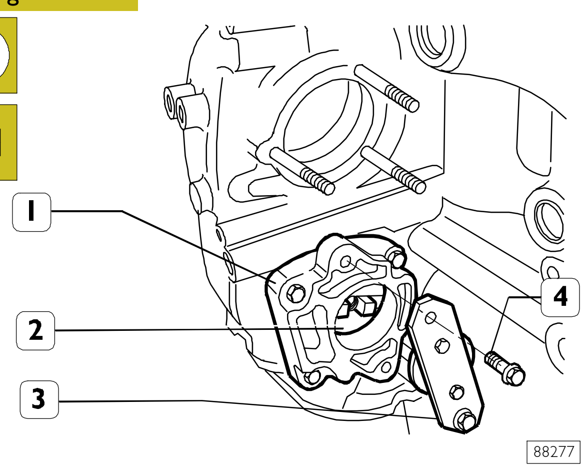
Remove the gear (1) and the chain (3) from the high pressure pump control shaft (2).

Figure 39



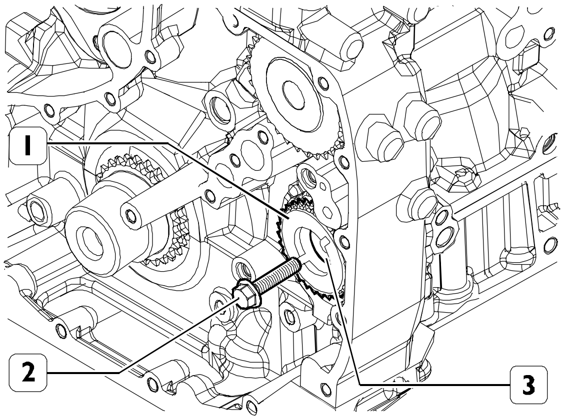
Remove the high pressure pump control shaft (3).
Remove the nuts (2) and the support (1).

Figure 40



Stop the rotation of the hydraulic power steering pump control shaft (2) by inserting tool 99360187 (3) in the shaft and fastening the tool on the support (1) by means of the screws (4).

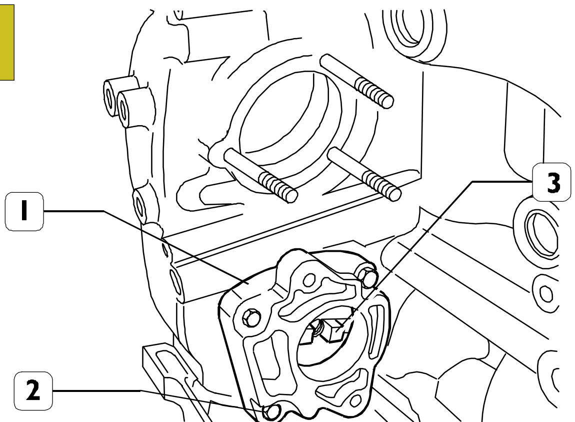
Figure 41



88278

Remove the screw (2) and the gear (1) from the hydraulic power steering control shaft (3).

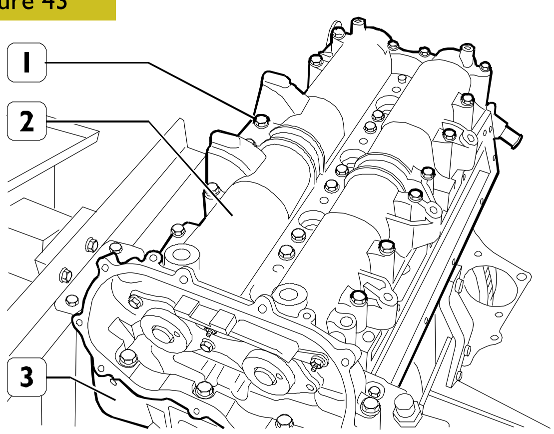
Figure 42



88279

Remove the hydraulic power steering control shaft (3).
Remove the nuts (2) and the support (1).

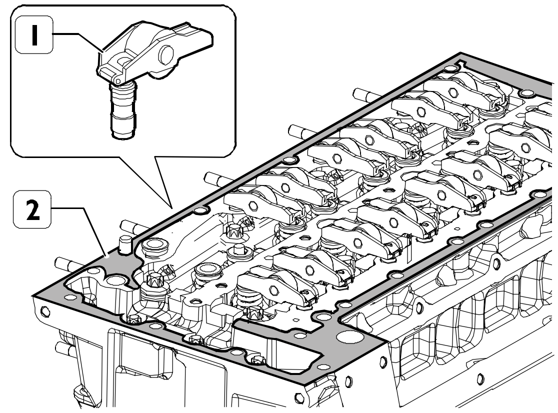
Figure 43



88280

Remove the screws (1) and take off the over-head (2) from the cylinder head (3).

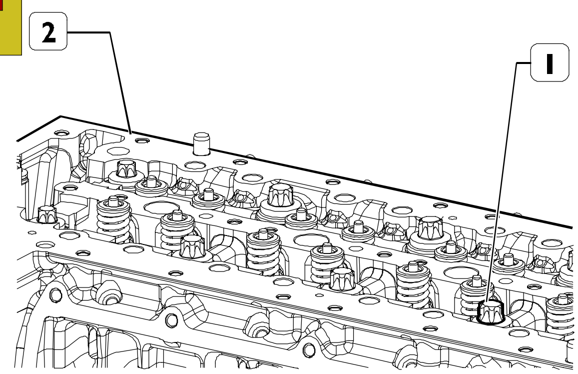
Figure 44



88281

Remove the hydraulic tappets (1) with the rocker arms.
Remove the gasket (2).

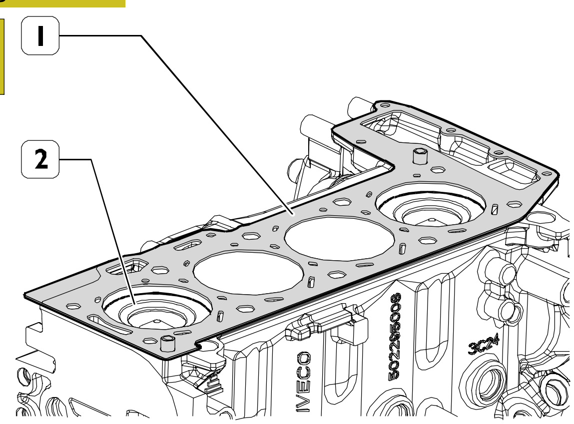
Figure 45



88282

Take out the screws (1) and remove the cylinder head (2).

Figure 46

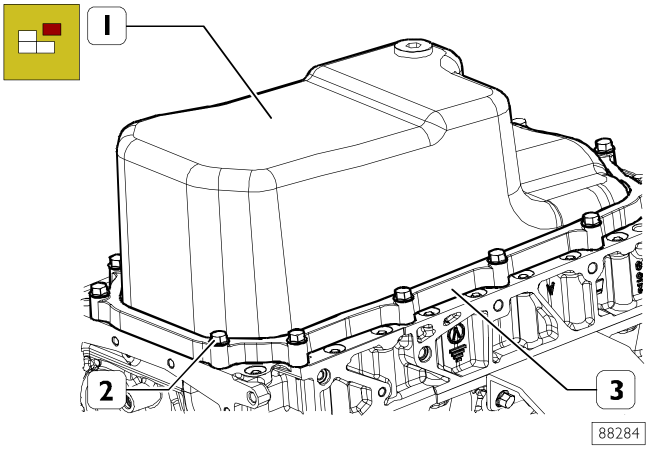


88283

Remove the cylinder head gasket (1).

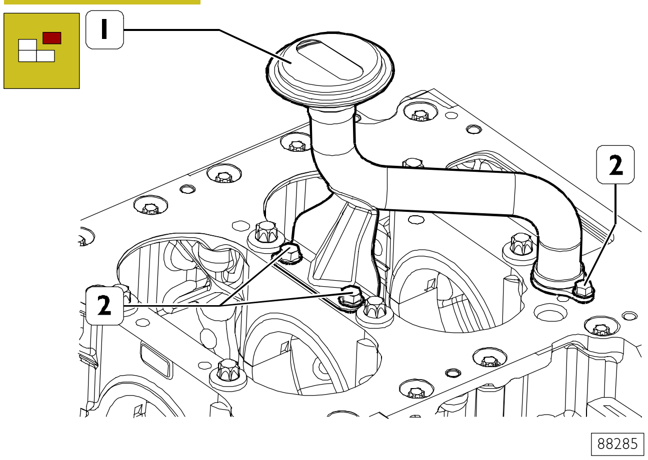
NOTE Check the protrusion of the pistons (2) as described under the relevant heading to check the possibility of facing the crankcase if it has deformed.

Figure 47



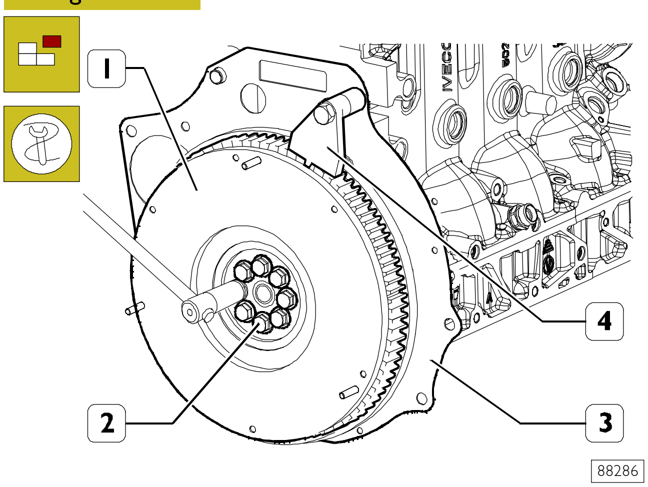
Remove the screws (2) and take off the oil sump (1) with its gasket and frame (3).

Figure 48



Remove the screws (2) and the suction rose (1).

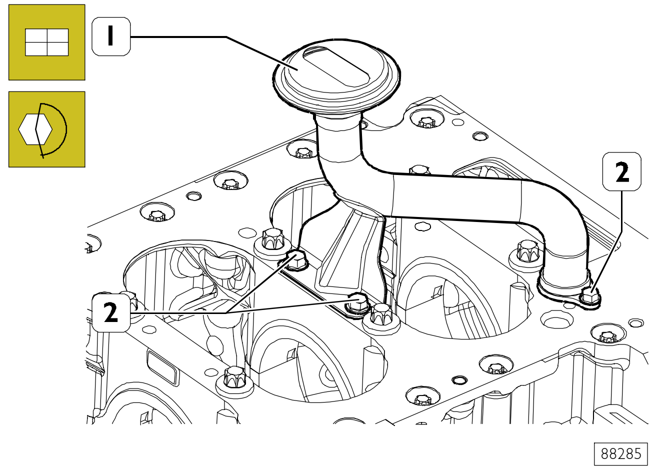
Figure 49



Block rotation of the flywheel (1) with tool 99360306 (4).
Take out the screws (2) and remove the engine flywheel (1).
Take out the guard (3).

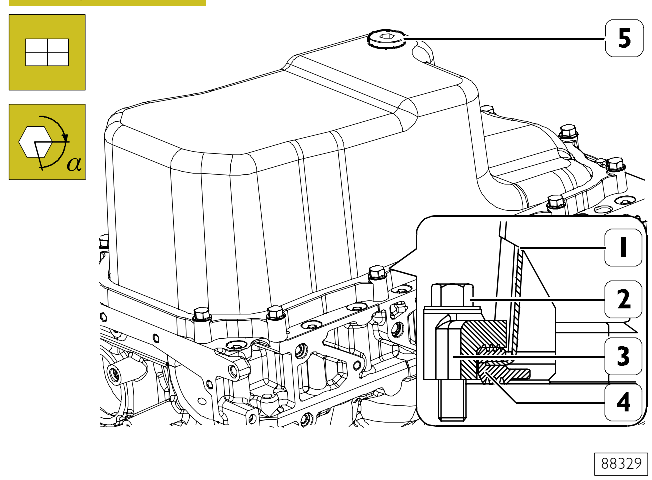
ASSEMBLY

Figure 50



Mount the suction strainer (1) together with the pipe.
Screw down the fixing screws (2) and tighten them to the prescribed torque.

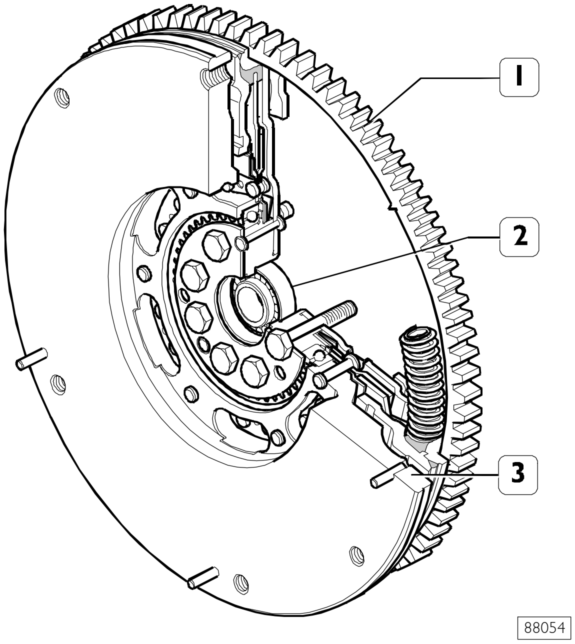
Figure 51



Fit the gasket (4) and the frame (3) onto the oil sump (1).
Screw down the fixing screws (2) and tighten them to the prescribed torque.
Screw down the oil drain plug (5) and tighten it to the prescribed torque.

ENGINE FLYWHEEL

Figure 52

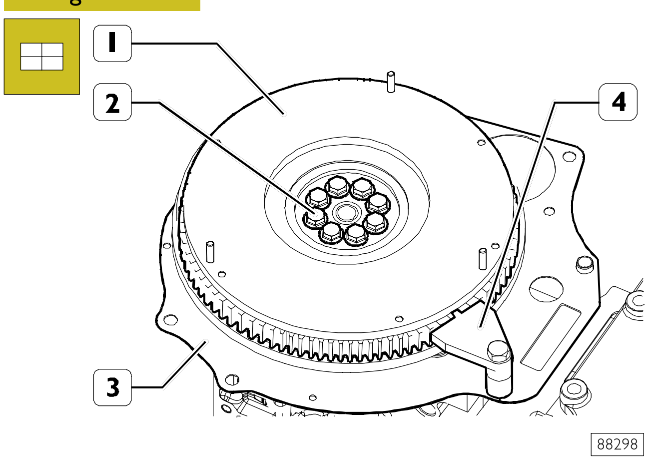


Double-mass engine flywheel, one integral with the drive shaft and one with the input shaft of the gearbox and in between a torsion elastic dampening system.
The advantages of this type of flywheel compared to the normal one are:

- ❑ Dampening of engine irregularities transmitted to the gearbox and resulting drive noise reduction;
- ❑ Noise reduction in the cabin as a result of the overall noise reduction.

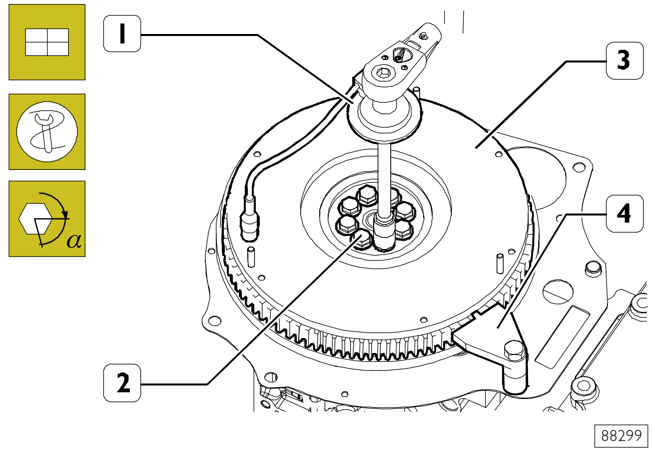
Check the clutch disc mating surface, if there are too many scratches, change the engine flywheel (3).
Check the conditions of the bearing (2) and the crown gear (1), if they are worn out or damaged change the engine flywheel (3).

Figure 53



Position the metal sheet guard (3) on the cylinder block.
Mount the engine flywheel (1) and screw down the screws (2).
Fit tool 99360351 (4) onto the crankcase to block rotation of the engine flywheel (1).

Figure 54



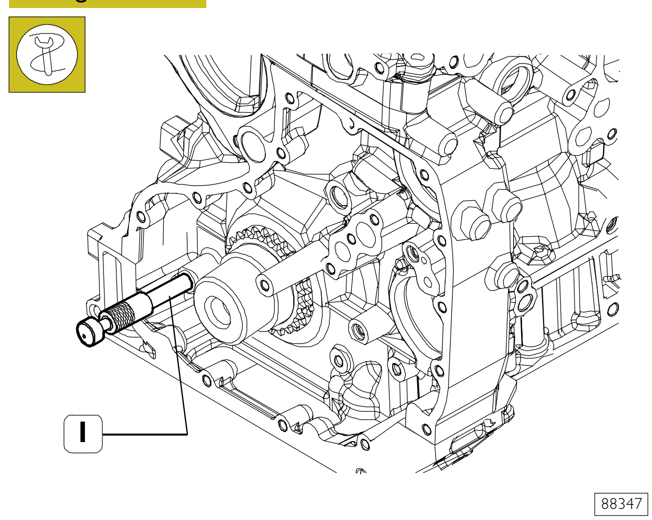
Tighten the screws (2) fixing the engine flywheel (3) in two steps:

- ❑ Step 1: with a torque wrench, to a torque of 30 Nm.
- ❑ Step 2: closing to an angle of 90°.

NOTE Use tool 99395216 (1) for the angle closing.

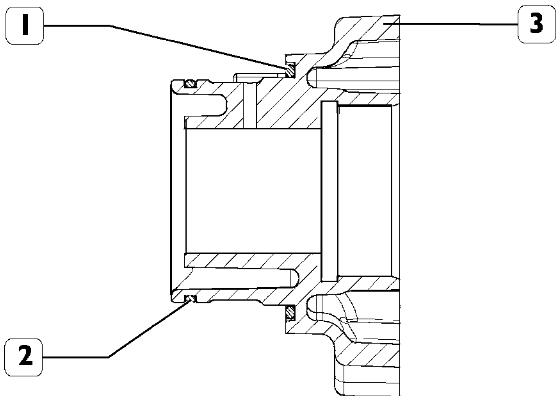
AUXILIARY PARTS CONTROL ASSEMBLY

Figure 55



Rotate the driving shaft so that the tool 99360615 (1) can be inserted in the shaft crank hole through the cylinder block hole, in order to stop the engine in the timing system setting condition.

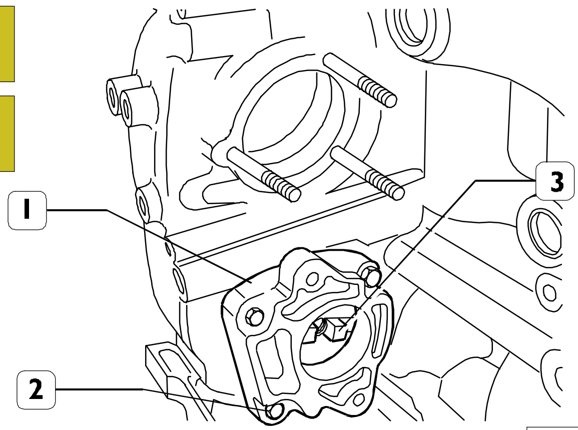
Figure 56



88348

Lubricate the seal rings (1 and 2) with engine oil and fit them on the support (3).

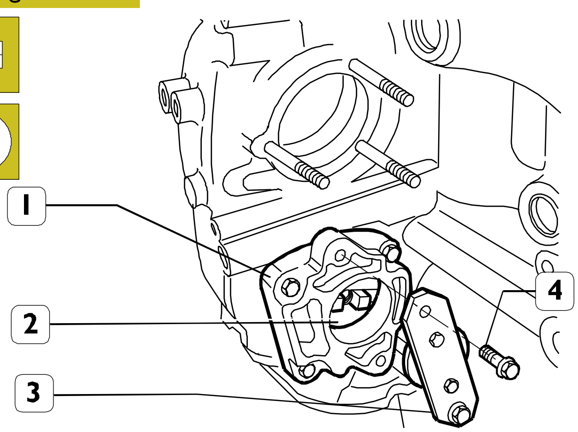
Figure 57



88279

Fit the support (1) and drive in the nuts (2), then tighten them to the prescribed torque.
Fit the stem (3).

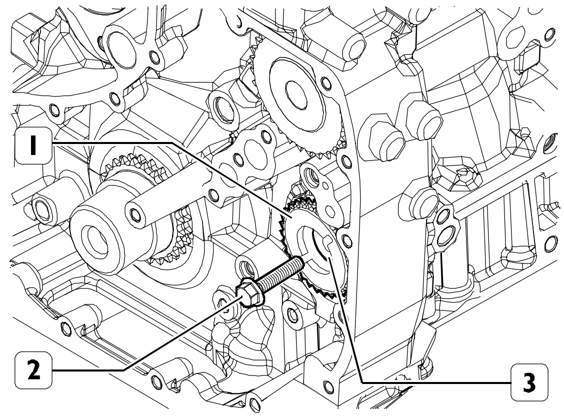
Figure 58



88277

Stop the stem rotation (2) of the hydraulic power steering pump by inserting in the latter the tool (3) and fastening the tool on the support (1) by means of the screws (4).

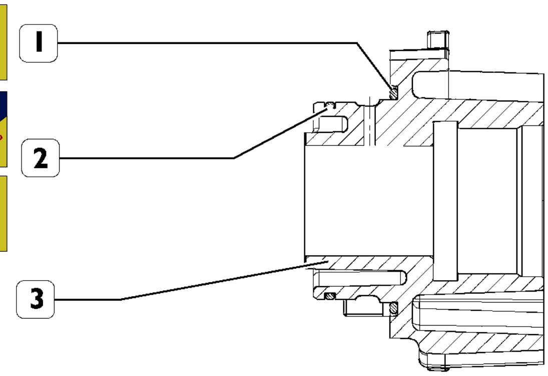
Figure 59



88278

Fit the gear (1) on the stem (3) of the hydraulic power steering pump.
Drive in the screw (2) without locking it.

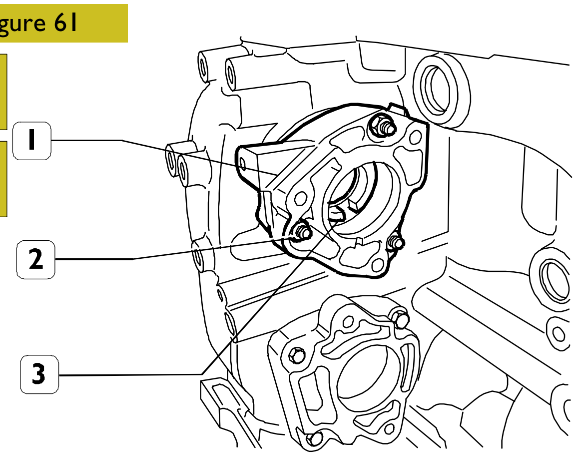
Figure 60



88349

Lubricate the new seal rings (1 and 2) with engine oil and fit them on the support (3).

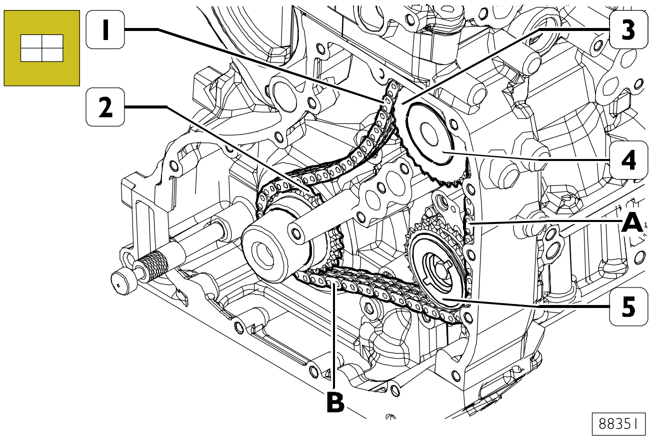
Figure 61



88276

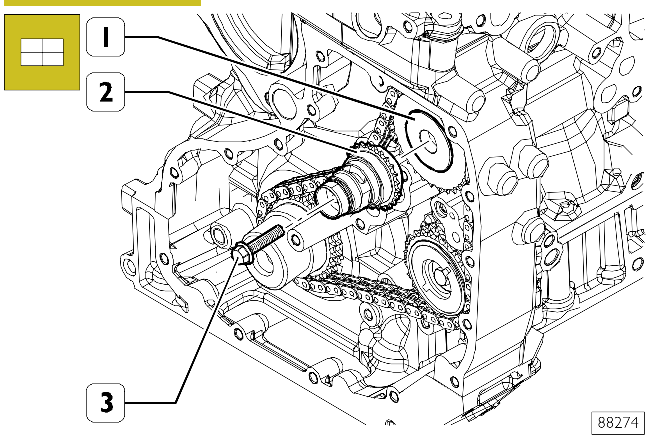
Fit the support (1), drive in the nuts (2) and tighten them to the prescribed torque.
Fit the control stem (3) of the high pressure pump.

Figure 62



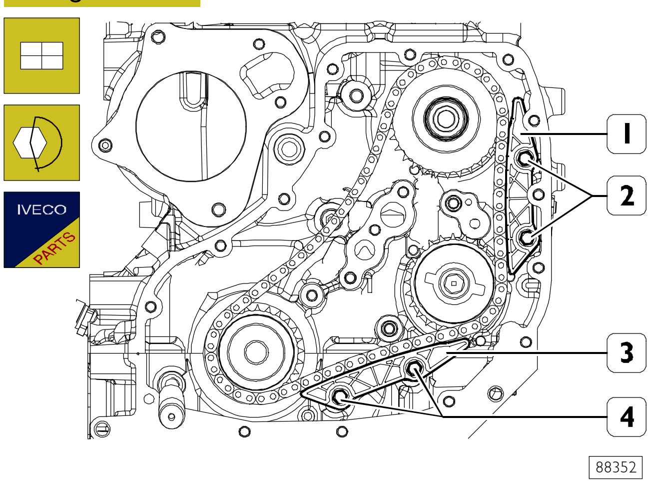
Position the chain (1) on the gears (2, 3 and 5) and fit the gear (3) on the stem (4) so that the chain (1) in tracts A and B is tensioned.

Figure 63



Fit the stem with the drive gear (2) on the high pressure pump control stem (1).
Drive in the fastening screw (3).

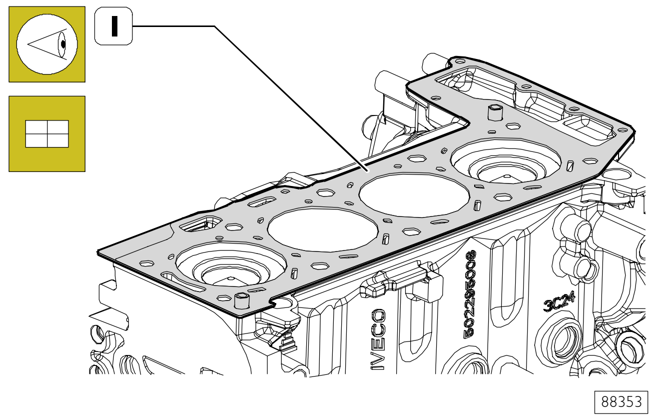
Figure 64



Check the conditions of the fixed skids (1 and 3) and change them if worn out.
Fit the skid (1) and drive in the fastening screws (2), then tighten them to the prescribed torque.
Fit the skid (3) and drive in the fastening screws (4), then tighten them to the prescribed torque.

Cylinder head refitting

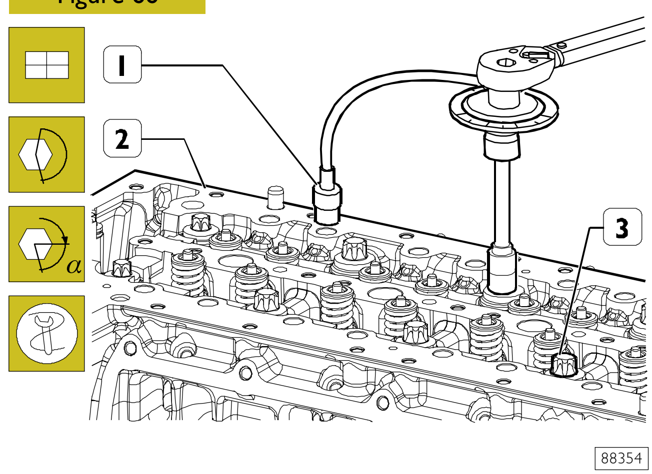
Figure 65



Check that the mating surfaces of the cylinder head and crankcase are clean.
Keep the cylinder head gasket clean.
Place the gasket (1) of the cylinder head with the thickness given in section "Check piston protrusion", with the "TOP" sign facing the head.

NOTE It is essential to keep the gasket sealed in its package until just before assembly.

Figure 66



Mount the cylinder head (2).

Screw down the fixing screws (3) and tighten them, in three successive stages, following the order and methods shown in the following figure.

NOTE The angle closure is done with tool 99395216 (1).

Figure 67

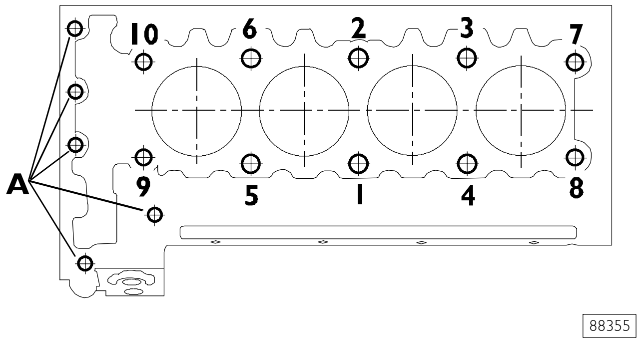
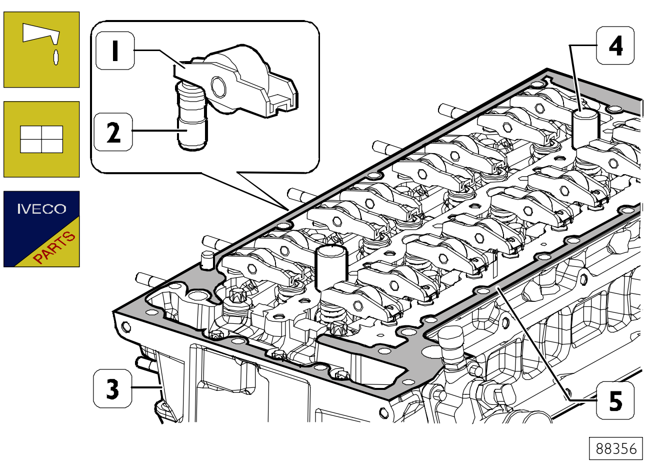


Diagram of the tightening sequence for the cylinder head fixing screws:

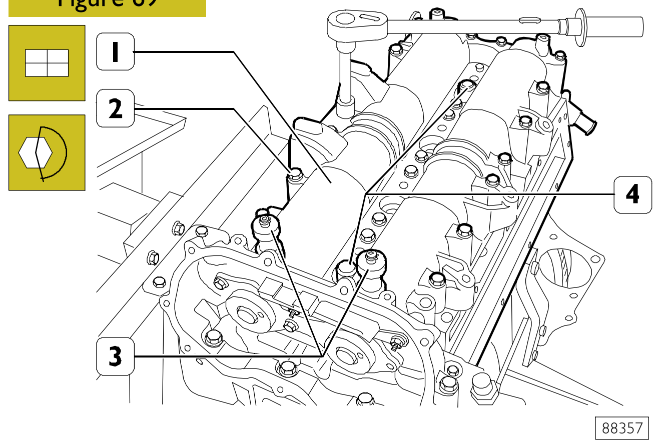
- 1st phase: pre-tightening with torque wrench
  - screws 1-2-3-4-5-6 to a torque of 130 Nm;
  - screws 7-8-9-10 to a torque of 65 Nm.
- 2nd phase: angle closing
  - screws 1-2-3-4-5-6 90°;
  - screws 7-8-9-10 90°.
- 3rd phase: angle closing
  - screws 1-2-3-4-5-6 90°;
  - screws 7-8-9-10 60°.
- Screws A, to a torque of 25 Nm.

Figure 68



Thoroughly clean the hydraulic tappets (2), lubricate them and fit them in the cylinder head (3), positioning the rocker arms (1) on the valves correctly.
Fit on the gasket (5).
Insert the two tools SP. 2264 (4) into the electro-injector seats for subsequent centring of the overhead on the cylinder head.

Figure 69

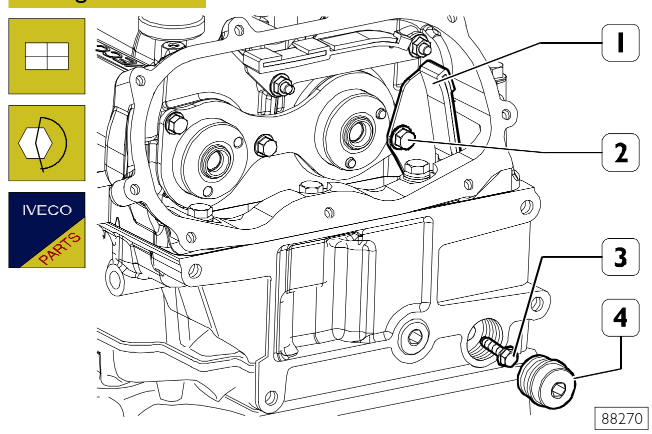


Mount the overhead (1) together with the tools 99360614 (3) for the timing and tighten the fixing screws (2) to the prescribed torque.

Take out the tools SP. 2264 (4).

TIMING SYSTEM CONTROL

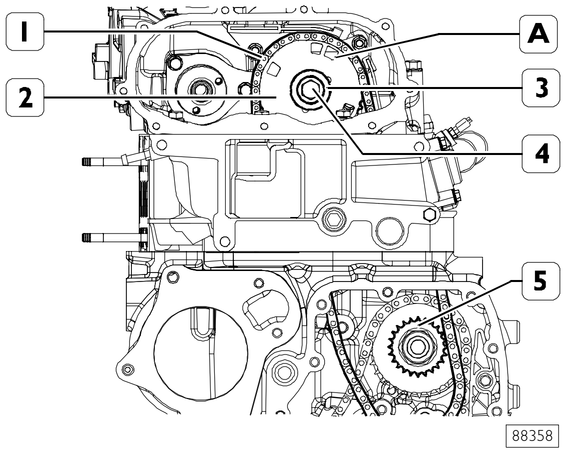
Figure 70



Fit the top fixed skid (1). Drive in the screws (2 and 3) and tighten them to the prescribed torque.

Fit the rubber cap (4) of the new gasket and tighten it to the prescribed torque.

Figure 71



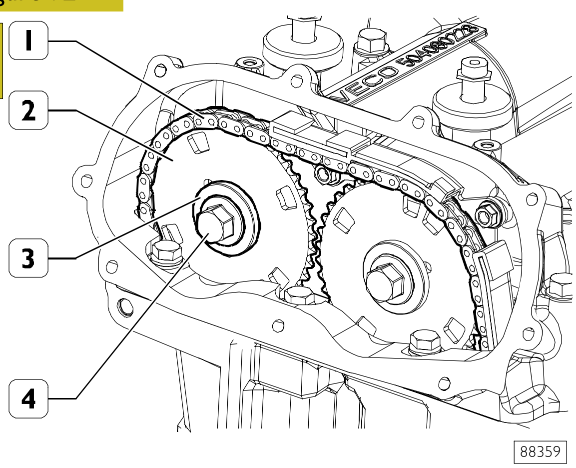
Position the chain (1) on the gear (5) and gear (2).

Mount the gear in such a way that fitting on aspiration valve timing system shaft dowel makes slots A to result to be positioned as in figure.

NOTE The chain arm (1) between the two gears must be tensioned.

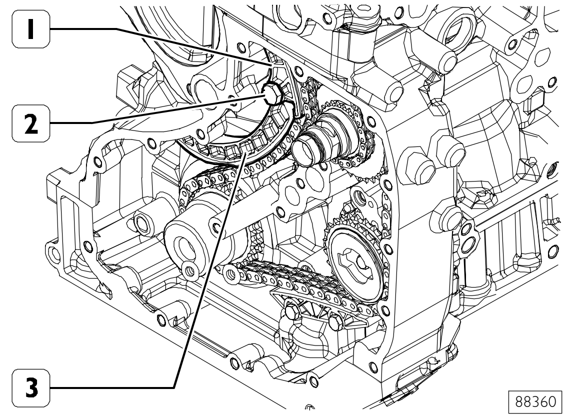
Drive in the fastening screw (4) with the washer (3) without tightening it completely.

Figure 72



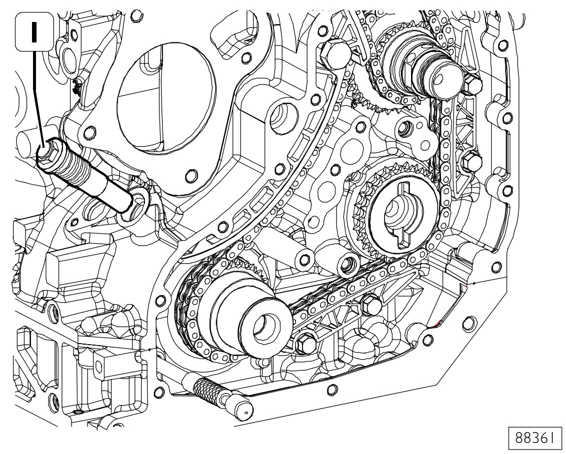
Position the chain (1) on the gear (2) and fit the latter on the camshaft of the exhaust valves.
Drive in the fastening screw (4) with the washer (3) without tightening it completely.

Figure 73



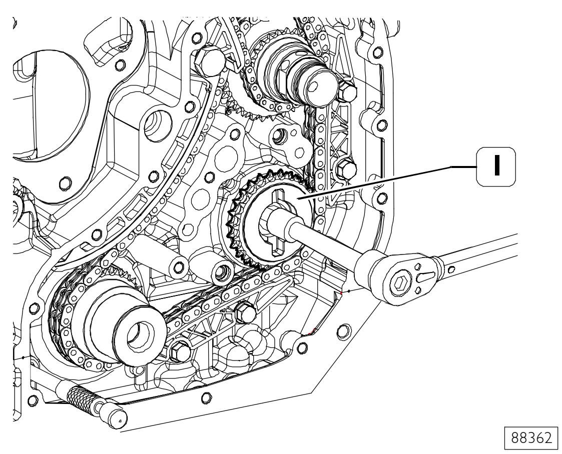
Check the conditions of the mobile skids (1 and 3), if worn out change them.
Position the mobile skids (1 and 3) and clamp them on the cylinder block by the pin (2) and tighten it to the prescribed torque.

Figure 74



Drive in the chain hydraulic tightener (1) and lock it to the prescribed torque.

Figure 75



Tighten the fastening screw of the gear (1) on the hydraulic power steering control stem to the prescribed torque.

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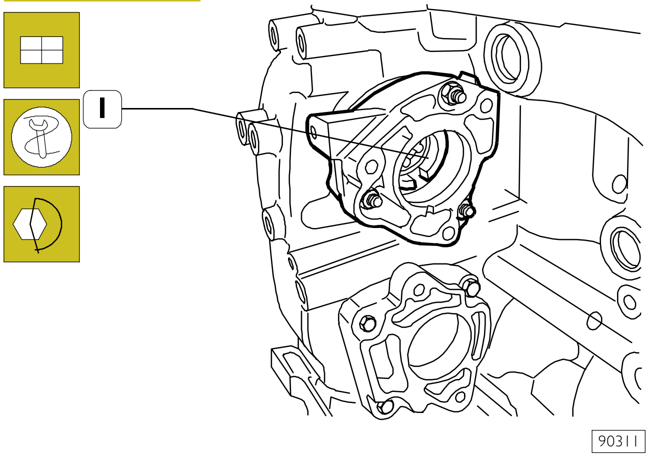
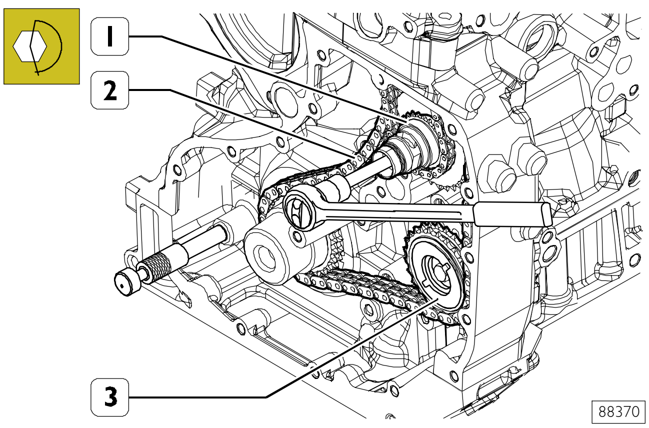
Figure 76



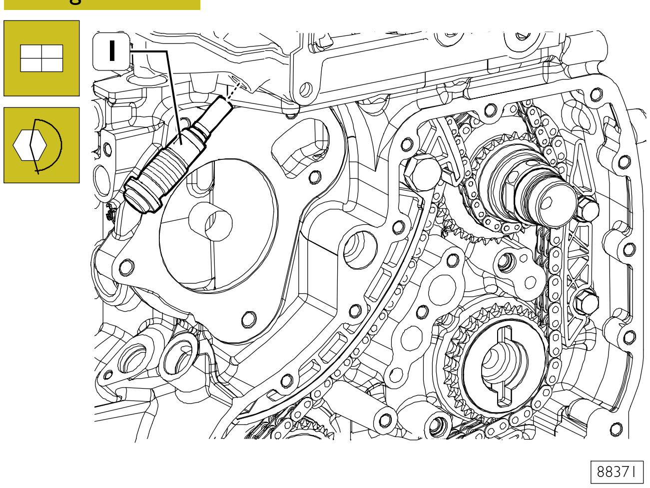
Stop the rotation of the high pressure pump control shaft (1) by inserting the suitable wrench inside it.

Figure 77



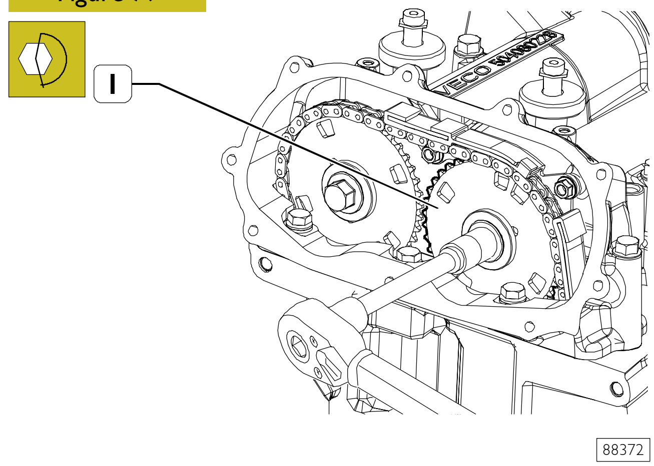
Make sure that the chain (2) and the tract between the gear (1) and gear (3) is tensioned.
Tighten the fastening screw of the stem with the drive gear (1) on the high pressure pump control stem to the prescribed torque.

Figure 78



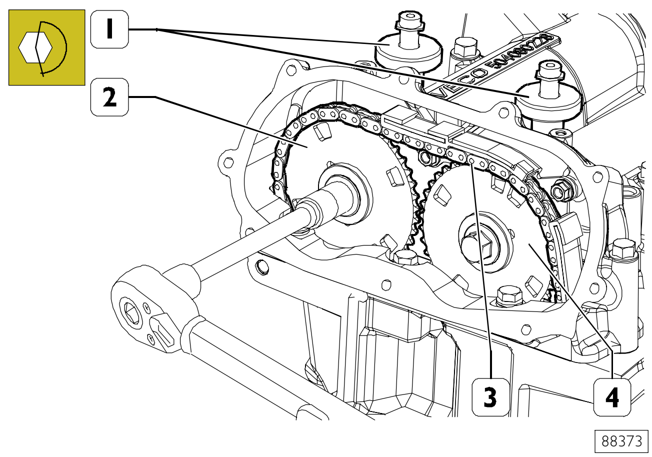
Drive the in the chain hydraulic tightener (1) and lock it to the prescribed torque.

Figure 79



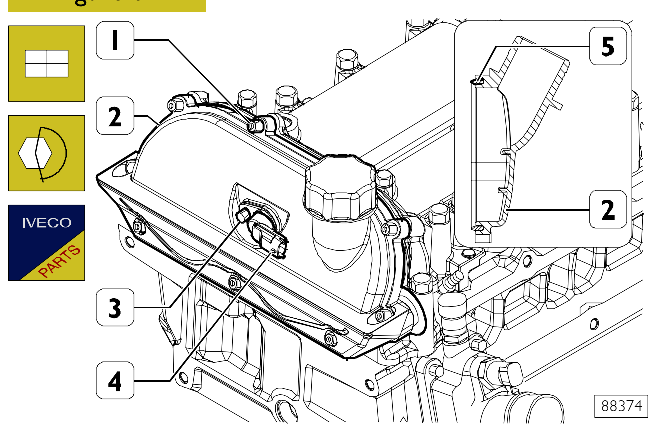
Tighten the fastening screw of the gear (1) on the suction valve camshaft to the prescribed torque.

Figure 80



Make sure that the chain (3) in the tract between the gear (2) and gear (4) is tensioned.
Tighten the fastening screw of the gear (2) on the exhaust valve camshaft to the prescribed torque.
Remove tools 99360614 (1).

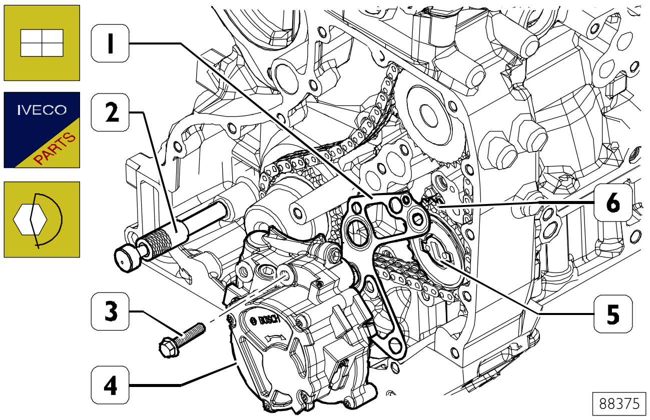
Figure 81



Fit a new gasket (5) in the cover (2).
Fit the cover (2), drive in the screws (1) and tighten them to the prescribed torque.
Fit the phase sensor (4).
Drive in the fastening nut (3) and tighten it to the prescribed torque.

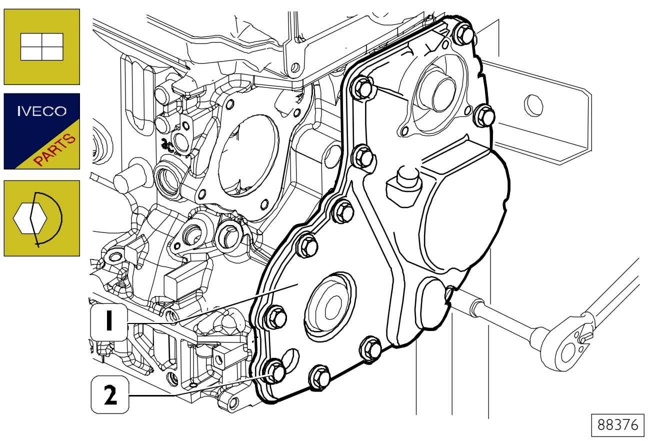
Oil pump assembly

Figure 82



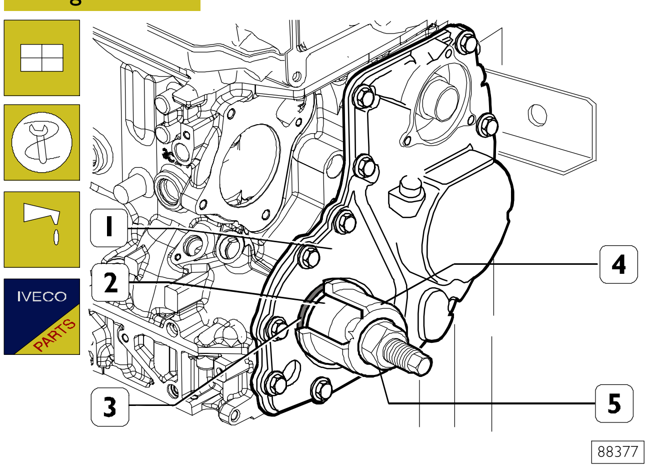
Position the joint (5) in the gear (6).
Fit the oil pump/depressor unit (4) by inserting a new gasket (1).
Drive in the screws (2) and tighten them to the prescribed torque.
Remove tool 99360615 (2).

Figure 83



Fit the cover (2) with a new gasket. Drive in the screws (2) without tightening them completely.

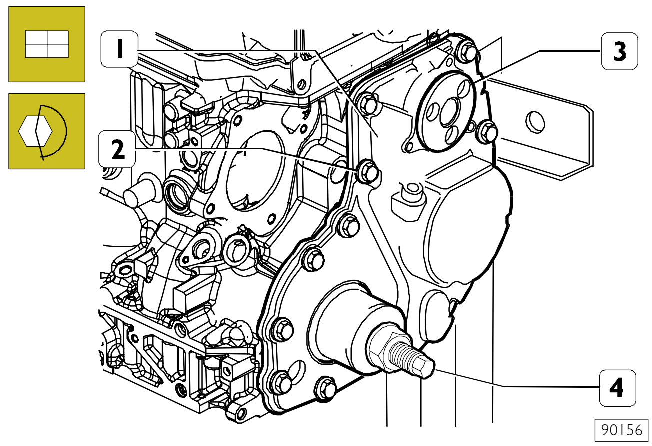
Figure 84



Clean accurately the seat of the cover seal ring (1).
Drive in the element (2) of tool 99346258 in the driving shaft tang.

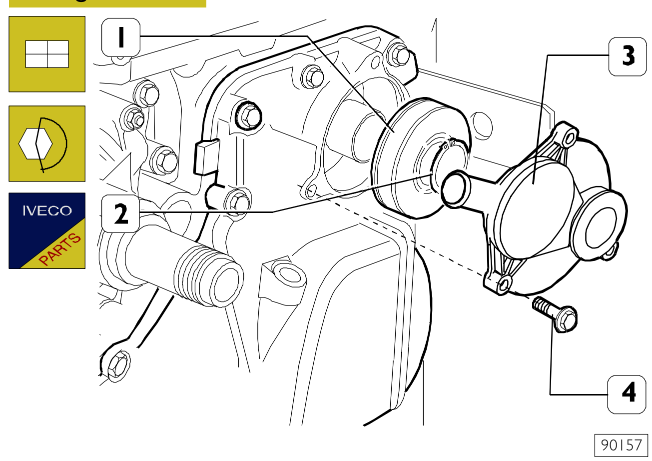
Lubricate the tang of the driving shaft and the element outside (2) and fit flush the new seal ring on this element (3). Position the element (4) on element (2), lock the nut (5) until fitting the seal ring (3) completely in the cover (1).

Figure 85



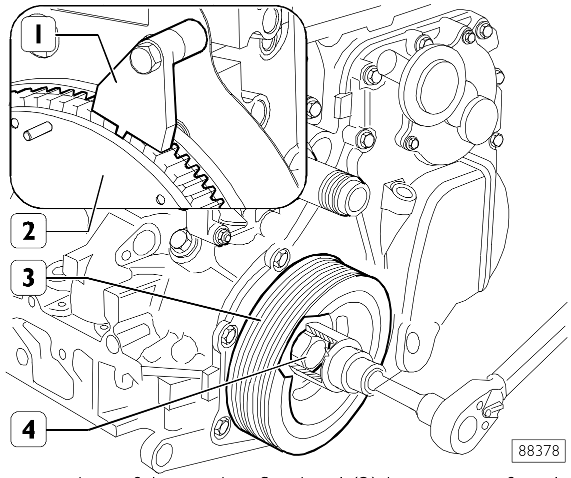
Mount tool 99396030 (3), for centering cover (1), into centrifugal filter seat and tighten screws (2) at prescribed torque. Remove: 99346258 (4) and 99396039 (3) tools.

Figure 86



Fit a new centrifugal filter (1).
Fit a new snap ring (2).
Fit the cover (3), drive in the screws (4) and tighten them to the prescribed torque.

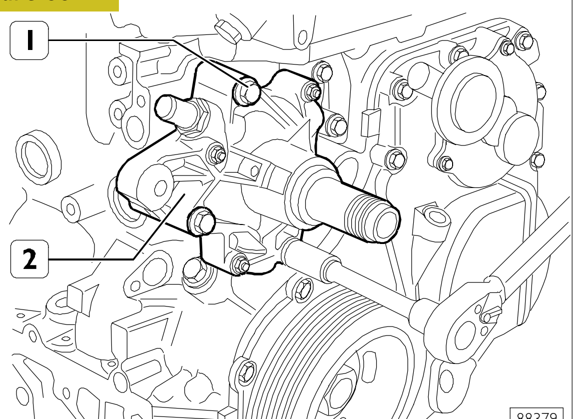
Figure 87



Stop the rotation of the engine flywheel (2) by means of tool 99360306 (1).
Fit the damper pulley (3). Drive in the screw (4) and tighten it to the prescribed torque.

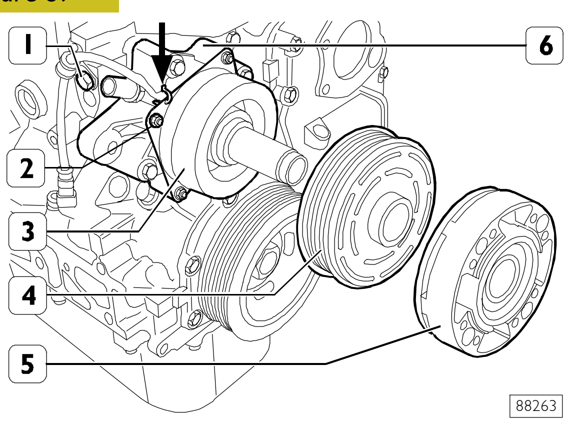
Water pump assembly

Figure 88



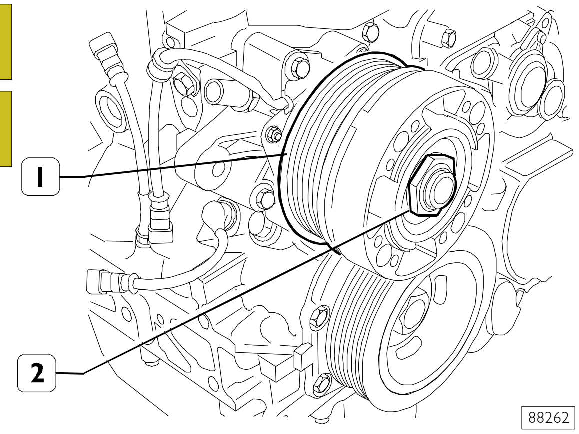
Fit the water pump (2) with a new gasket. Drive in the screws (1) and tighten them to the prescribed torque.

Figure 89



Fit the electric magnet (3) of the cooling fan joint on the water pump (6).
Drive in the nuts (2) and tighten them to the prescribed torque.
Drive in the fastening screw (1) of the wire clamp and tighten it to the prescribed torque.
Lock the electric magnet (3) wire by means of the clamp (→).
Fit the pulley (4) and the hub (5).

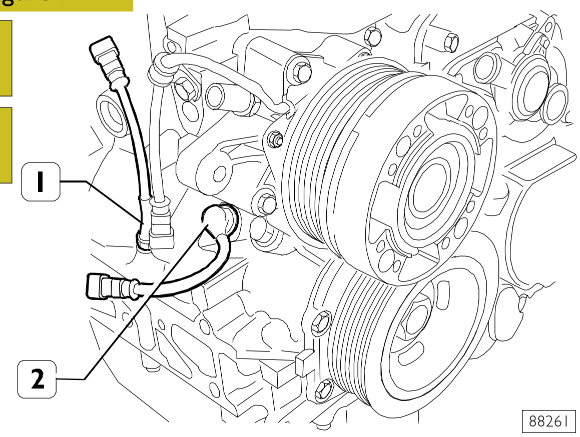
Figure 90



Stop the rotation of the electro-magnetic joint (1).
Drive in the nut (2) and tighten it to the prescribed torque.

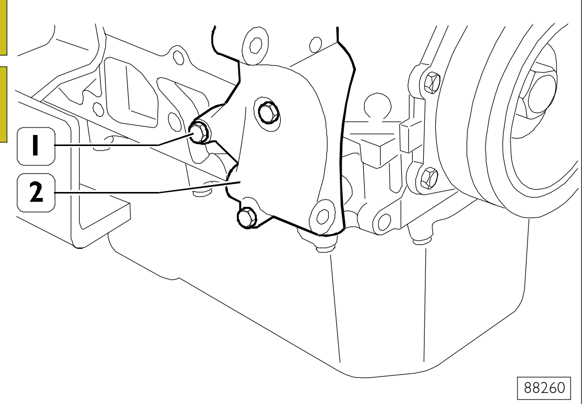
NOTE The nut (2) must be driven in anticlockwise because its threading is left-handed.

Figure 91



Drive in the oil level sensor (1) and tighten it to the prescribed torque.
Fit the rev sensor (2), drive in the fastening screw and tighten it to the prescribed torque.

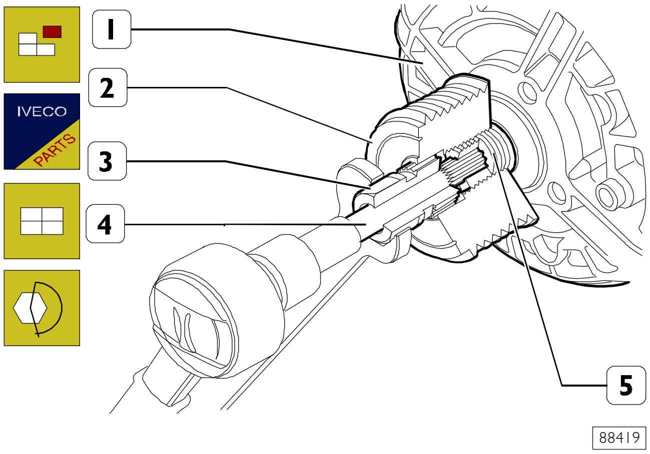
Figure 92



Fit the support (2), drive in the screws (1) and tighten them to the prescribed torque.

Replacement of alternator free wheel

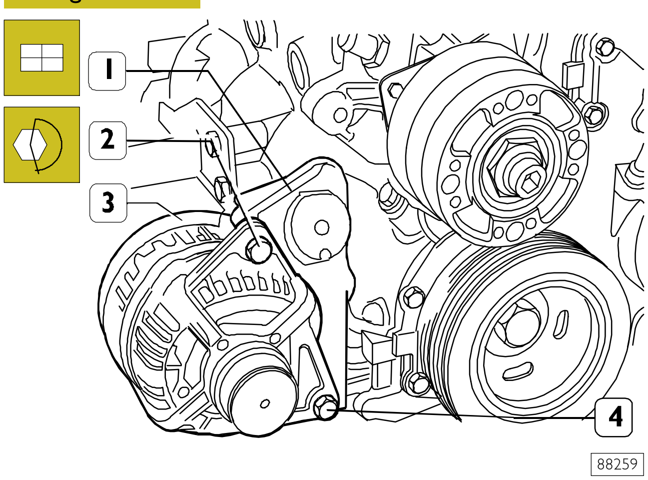
Figure 93



The free wheel (2) function is to prevent that the engine idling oscillations bounce back though the control belt on the alternator (1).
If it is necessary to change the free wheel (2), operate as follows.

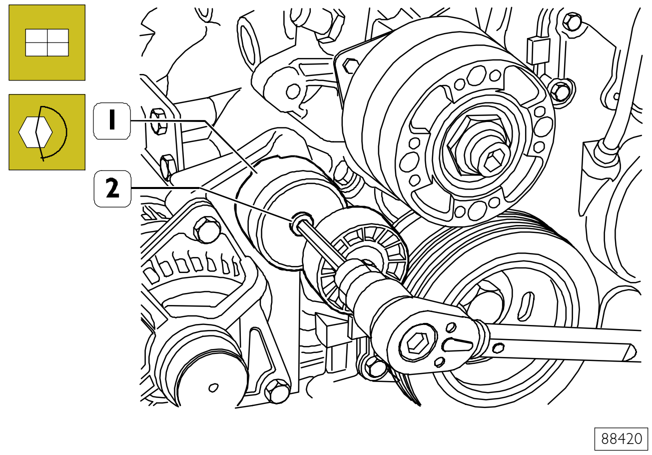
Remove the protection cap from the free wheel (2).
Apply tool 99358026 (3 and 4) as illustrated in the figure.
Stop the rotation of the free wheel (2) with the element (3) and slacken the stem (5) of the alternator (1) with the element (4).
Fit the new free wheel (2) by reversing the removal operations. The free wheel (2) must be clamped on the stem (5) by applying a max torque of 85 Nm.

Figure 94



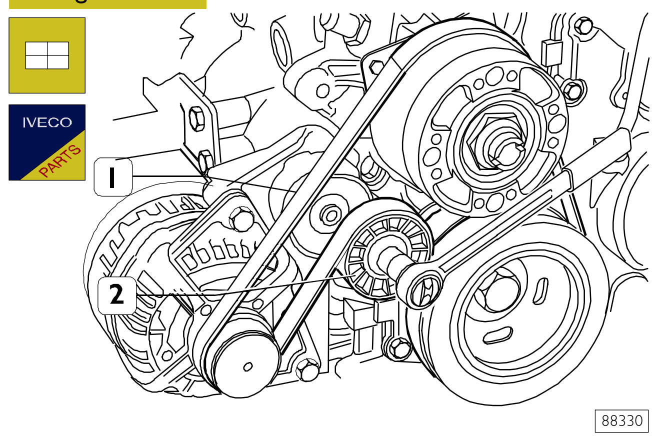
Fit the alternator (3) on the support (1), lock it with the bolt (4) and the screw (2) and tighten them to the prescribed torque.

Figure 95



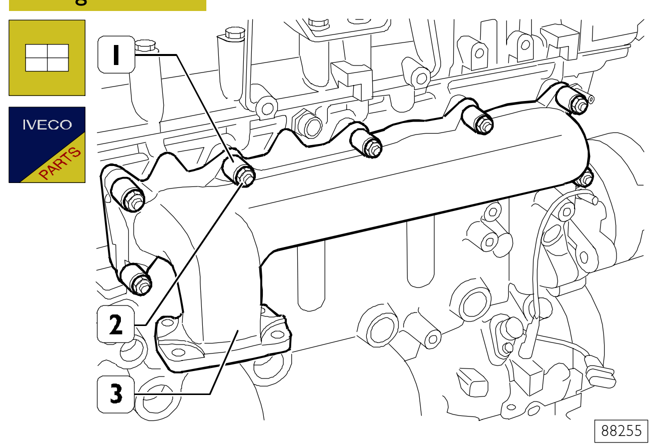
Fit the automatic backstand (1), drive in the screw (2) and tighten it to the prescribed torque.

Figure 96



Operate the automatic backstand (2) with the suitable wrench, fit the belt (1) and make sure the ribs are positioned correctly in the respective pulley races.

Figure 97



Fit the exhaust manifold (3) with a new gasket.
Fit the spacers (1), drive in the nuts (2) and tighten them to the prescribed torque.

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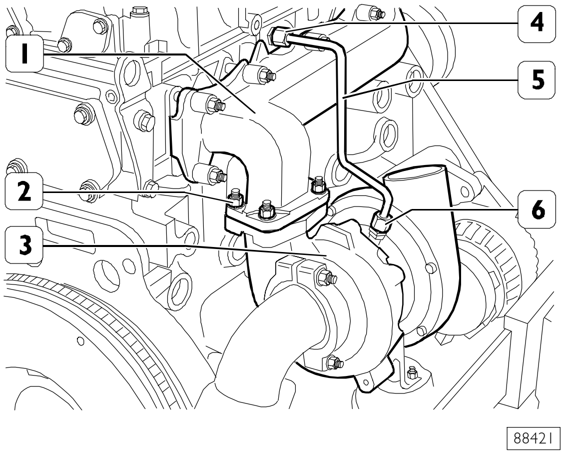
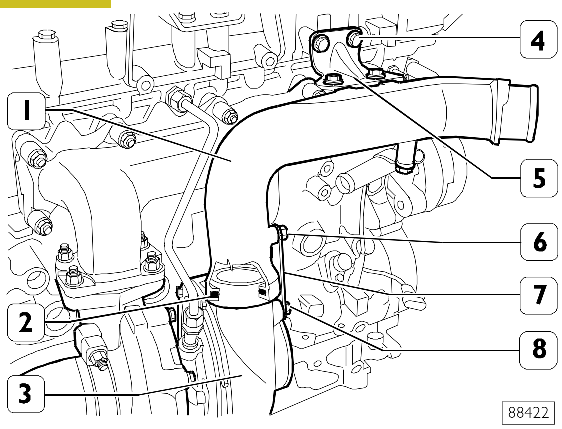
Figure 98



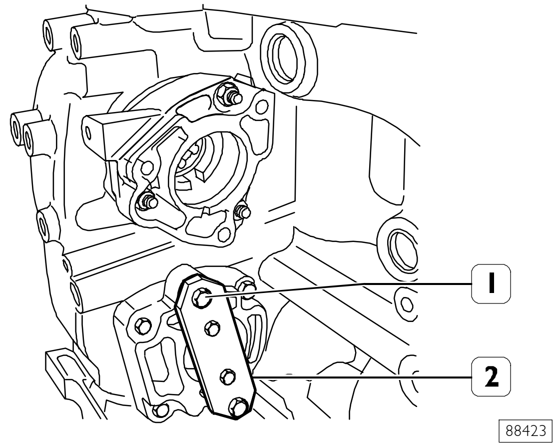
Fit the turbocharger (3) with the relevant gasket on the exhaust manifold (1). Drive in the nuts (2) and tighten them to the prescribed torque.
Connect the oil pipe (5) to the turbocharger (3) and the cylinder head, and tighten the pipe unions (4 and 6) to the prescribed torque.

Figure 99



Fit a new seal ring (2) in the air vent (1).
Slightly lubricate the seal ring (2), fit the air vent (1) on the turbocharger (3), position the bracket (7), drive in the fastening screws (6 and 8) and tighten them to the prescribed torque.
Drive in the fastening screws (4) of the bracket (5) on the cylinder head and tighten them to the prescribed torque.

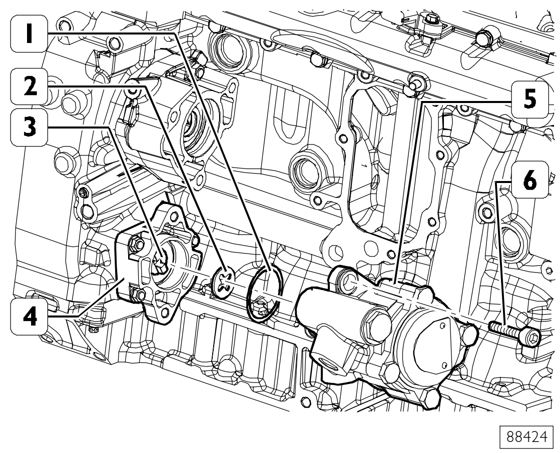
Figure 100



Remove the fastening screws (1) and remove tool 99360187 (2).

Steering pump assembly

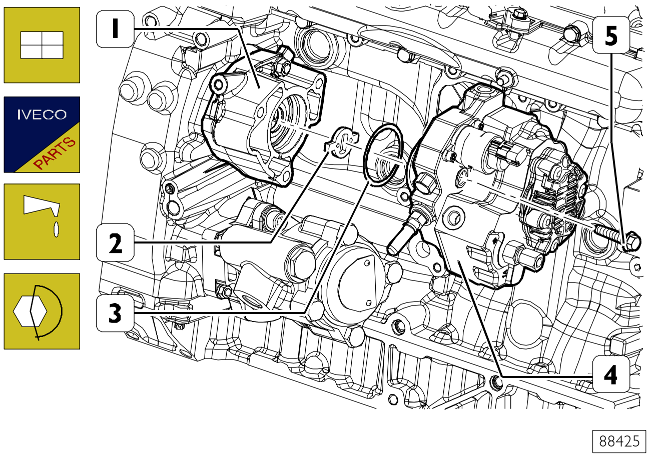
Figure 101



Position the joint (2) on the stem (3).
Slightly lubricate the seal ring (1) and fit it on the power steering pump (5).
Fit the power steering pump on the support (4).
Drive in the fastening screws (6) and tighten them to the prescribed torque.

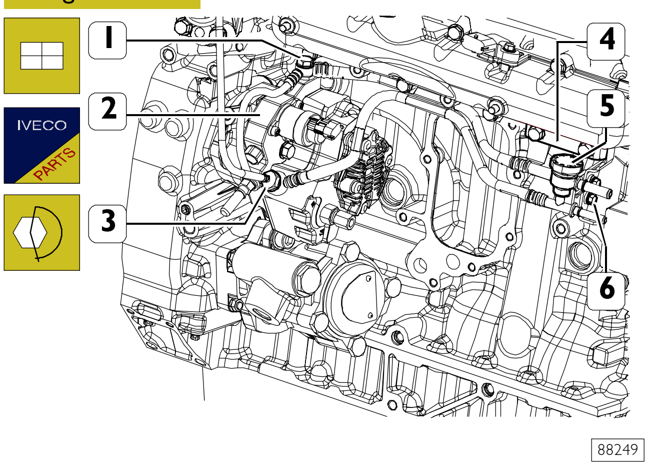
Assembly of high pressure pump and fuel supply

Figure 102



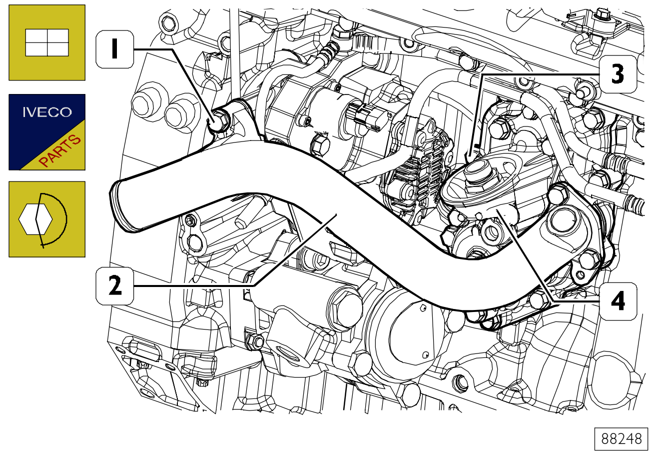
Lubricate a new seal ring (3) and fit it on the high pressure pump (4).
Position the joint (2) on the high pressure pump stem (4).
Fit the high pressure pump (4) on the support (1), drive in the screws (5) and tighten them to the prescribed torque.

Figure 103



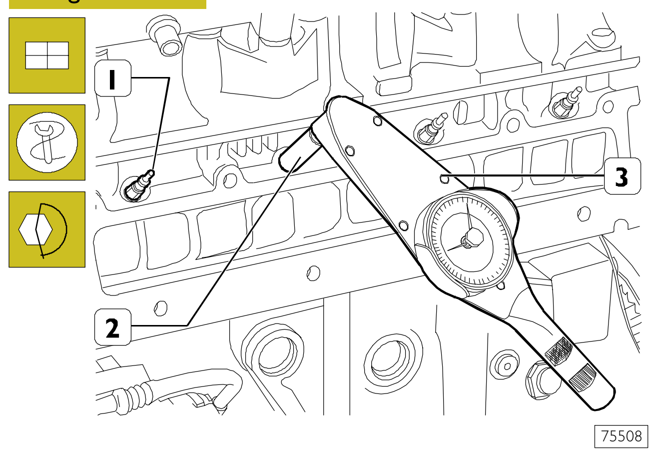
Connect the low pressure pipes (5) with the new gaskets to the high pressure pump (2) and tighten the pipe unions (1 and 3) to the prescribed torque.
Drive in the fastening screw (6) of the pipe (5) on the bracket (4) and tighten it to the prescribed torque.

Figure 104



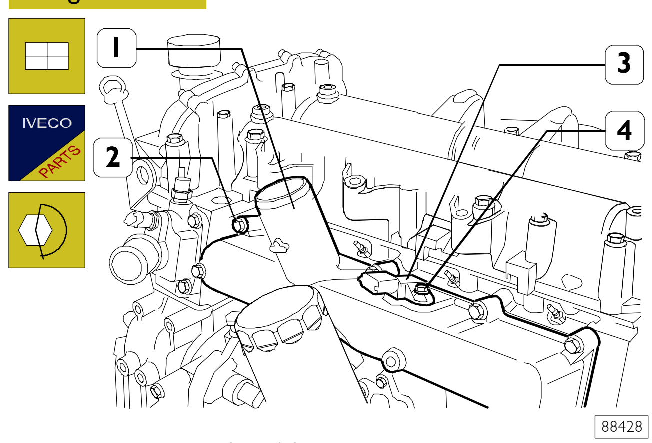
Fit the heat exchanger (4) with the new gasket and the pipe (2) on the cylinder block.
Drive in the screws (1 and 3) and tighten them to the prescribed torque.

Figure 105



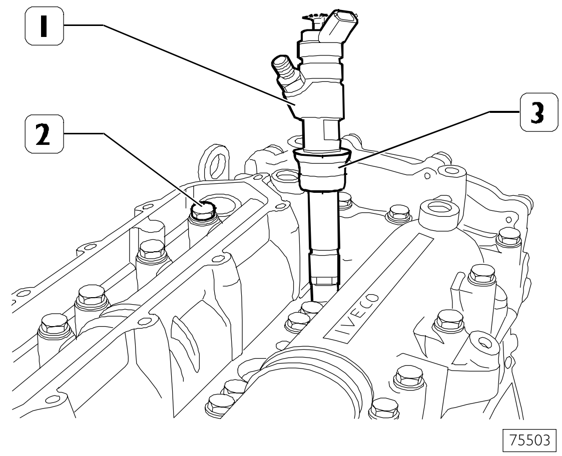
Mount the glow plugs (1) and, using the box-type wrench SP. 2275 (2) and torque wrench 99389819 (3), tighten them to a torque of 8 ÷ 10 Nm.

Figure 106



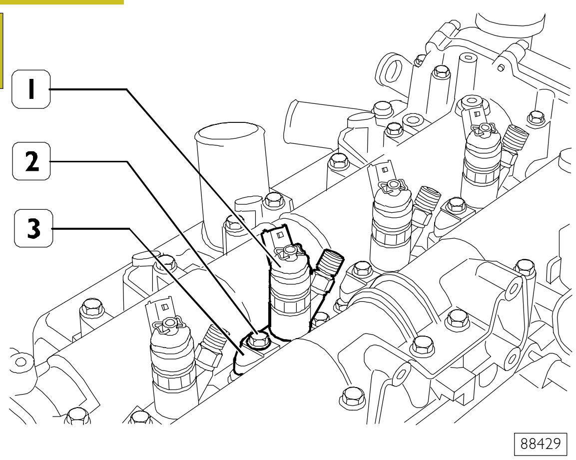
Fit the suction manifold (1) with a new gasket.
Drive in the screws (2) and tighten them to the prescribed torque. Fit the air temperature and pressure sensor (3).
Drive in the screw (4) and tighten it to the prescribed torque.

Figure 107



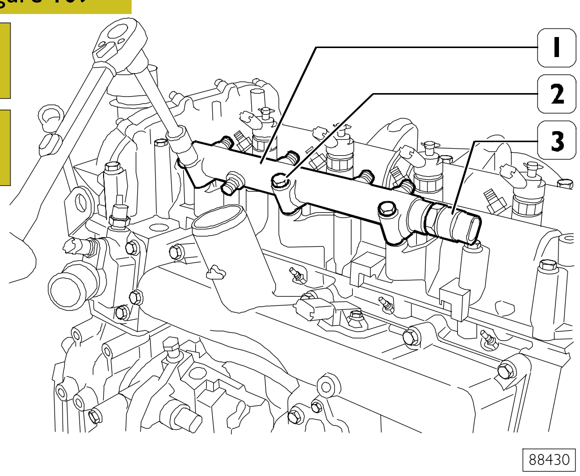
Fit a new seal (3) on the electro-injector (1) and mount this in the overhead (2).

Figure 108



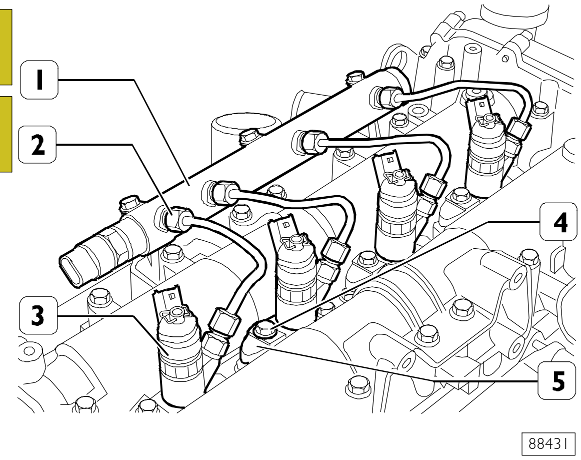
Mount the brackets (3) fastening the electro-injectors (1) and screw down the screws (2) without locking them.

Figure 109



Mount the hydraulic accumulator (1) and tighten the fixing screws (2) to the prescribed torque.
Fit the pressure sensor (3) on the hydraulic accumulator (1) and tighten it to the prescribed torque.

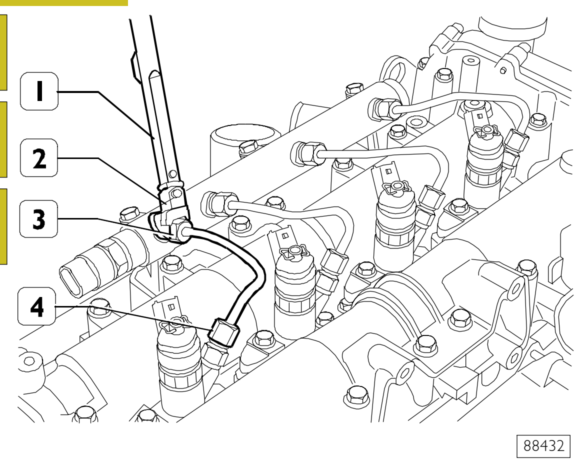
Figure 110



Connect the fuel pipes (2) to the electro-injectors (3) and to the hydraulic accumulator (1).
Tighten the screws (4) fixing the electro-injector brackets (5) to the prescribed torque.

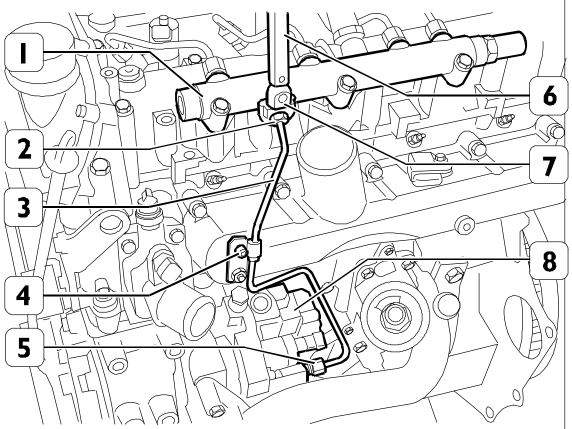
NOTE Whenever they get removed, the fuel pipes must be replaced with new ones.

Figure 111



Using the wrench (2) of the 99317915 series and the torque wrench 99389829 (1), tighten the fuel pipe fittings (3) and (4) to the prescribed torque.

Figure 112



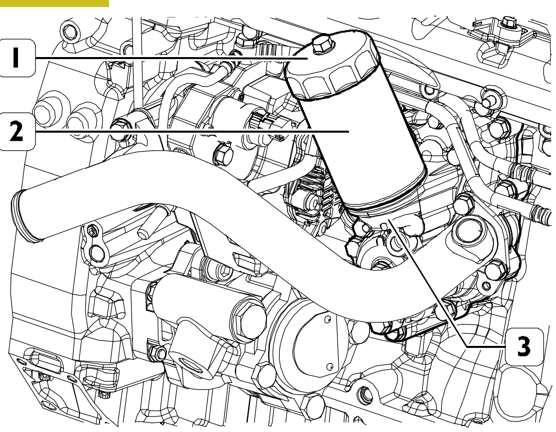
88433

Connect the fuel pipe (3) to the hydraulic accumulator (1) and to the high-pressure pump (8).
Tighten the couplings (2 and 5) using a wrench (7) in the 99317915 series and the torque wrench 99389829 (6).

NOTE Whenever they get removed, the fuel pipes (3) must be replaced with new ones.

Fasten the pipe (3) on the support bracket with the bolt (4) tightened to the prescribed torque.

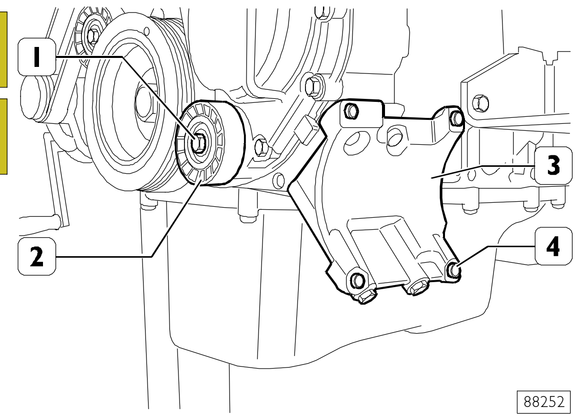
Figure 113



88434

Lubricate the seal ring of the oil filter (2) with engine oil and fasten it on the heat exchanger (3). Use tool 99360076 (1) to tighten the oil filter to the prescribed torque.

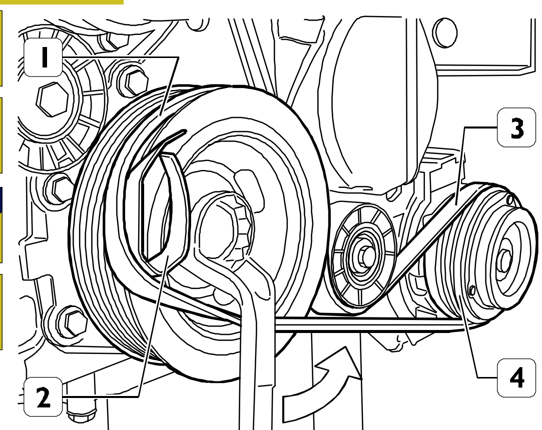
Figure 114



88252

If present, fit the support (3), drive in the screws (4) and tighten them to the prescribed torque.
Fit the fixed backstand (2), drive in the screw (1) and tighten it to the prescribed torque.

Figure 115

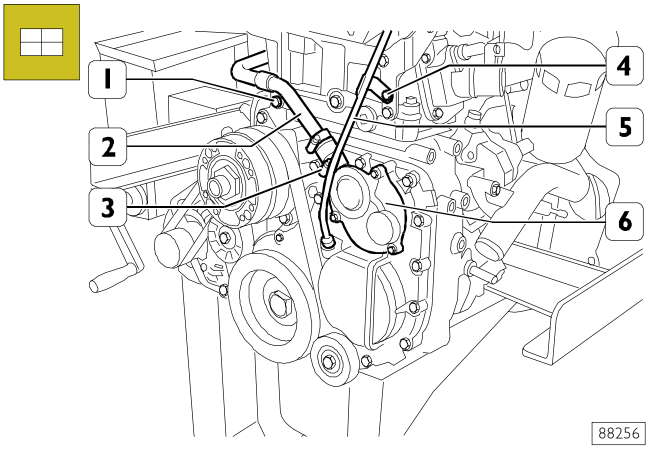


90650

Fit (if present) the compressor of the air conditioner and tighten the fastening screws to the prescribed torque.

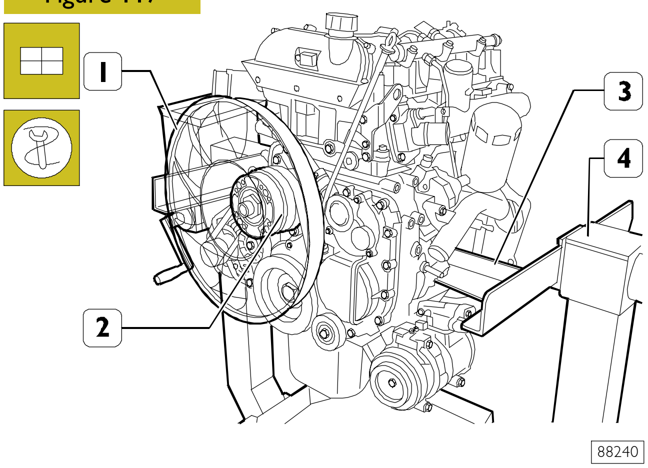
Fit the flexible belt (3) equipped with tool 99360191 (2) on the pulley (4) and apply the tool on the pulley (1).
Turn the drive shaft counterclockwise (⇒) until the belt fits perfectly on the pulley (1).

Figure 116



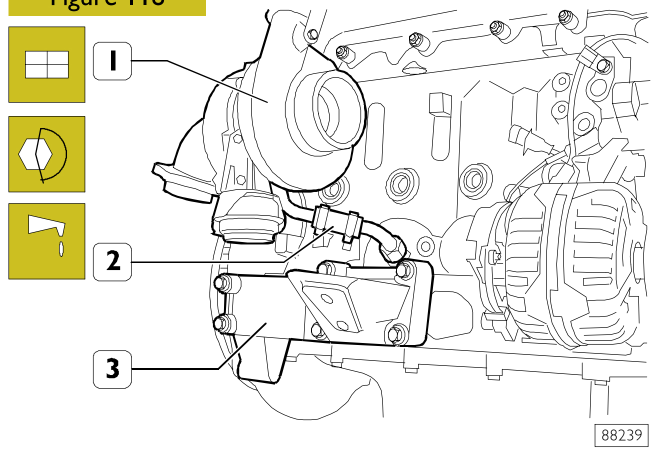
Connect the pipe (2) to the cover (6) and fasten it with the clamp (3).
Drive in the screw (1) and tighten it to the prescribed torque.
Fit the pipe (5) of the oil level dip rod and fasten the support bracket on the cylinder head by tightening the screw (4) to the prescribed torque.

Figure 117



If present, refit the cooling fan (1) to the electro-magnetic joint (2). Apply the spring equalizing rocker arm on the engine lifting hooks, fasten the rocker arm to the hoist and remove the engine from the rotating stand (3).
Remove the brackets 99361041(3).

Figure 118

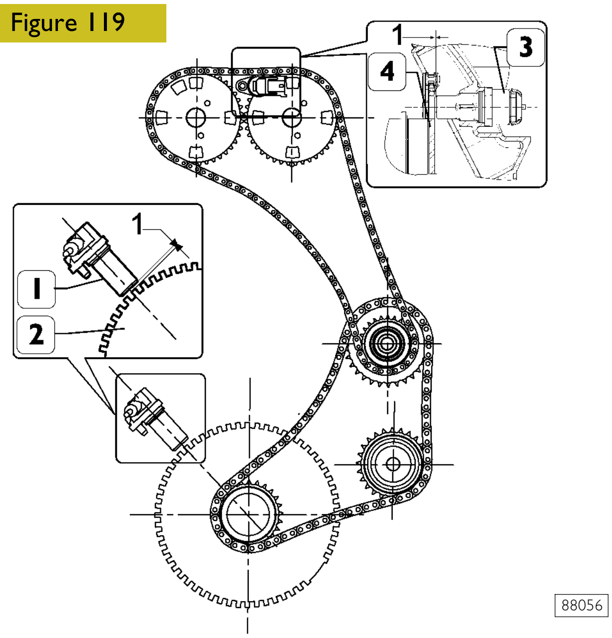


Complete engine assembly.
Fit on the left and right engine mountings (3) and tighten the fixing screws to the prescribed torque.
Connect the oil pipe (2) to the turbocharger (1) and to the crankcase and tighten the fixing screws and the coupling of the oil pipe (2) to the prescribed torque.
If applicable, mount the following parts:

- Engine cable, connecting its electrical connections to the thermostat temperature sensor, timing sensor, engine speed sensor, pressure regulator, rail pressure sensor and intake manifold air pressure/temperature sensor.
- Hydraulic accumulator guard.
- Top soundproofing cover.
- Add the prescribed grade and quantity of lubricating oil to the engine.

Timing speed sensor
Engine speed sensor

Figure 119



The sensor gap is:

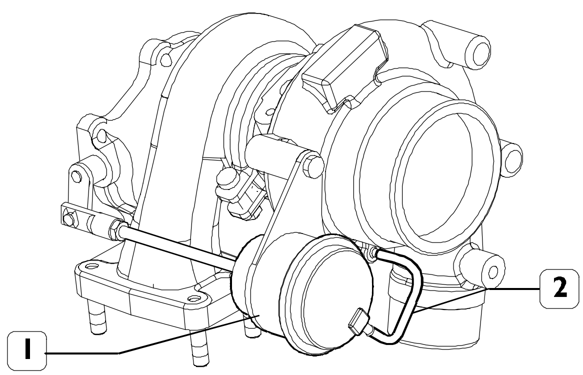
- 1 mm, between the gear (4) of the camshaft and the phase sensor (1).
- 1 mm, between the phonic wheel (2) and speed sensor (1).

REPAIRS

NOTE On finding irregular engine operation due to the turbocharging system, it is first expedient to perform the checks on the turbocharger, check the efficiency of the seals and the fixing of the couplings, additionally checking there is no clogging in the intake sleeves, air filter or radiators. If the turbocharger damage is due to a lack of lubrication, check that the oil circulation pipes are not burst or clogged, in which case replace them or eliminate the trouble.

Pressure relief valve
Checking and adjusting pressure relief valve

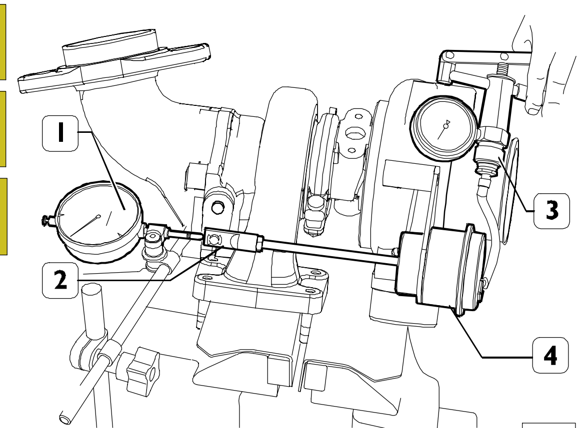
Figure 120



88622

Cover the air, exhaust gas and lubricating oil inlets and outlets. Thoroughly clean the outside of the turbocharger using anticorrosive and antioxidant fluid. Disconnect the pipe (2) from the union of the pressure relief valve (1) and fit on it the pipe of the device 99367121 (3, Figure 121).

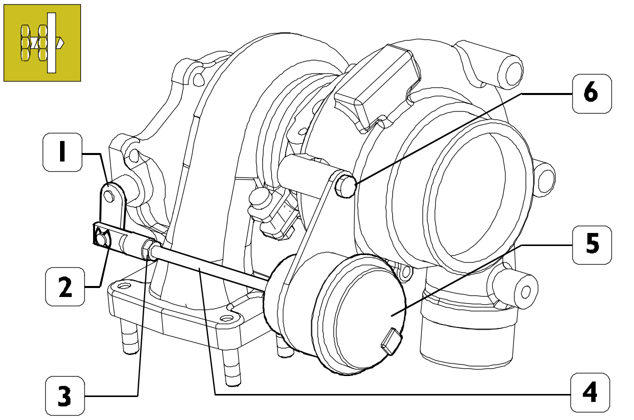
Figure 121



88623

Rest the tip of the dial gauge (1) with a magnetic base on the end of the tie rod (2) and zero it. Using the device 99367121 (3), introduce compressed air into the valve casing (4) at the prescribed pressure and make sure this value stays constant throughout the check; replace the valve if it doesn't. In the above conditions, the tie rod must have made the prescribed travel.

Figure 122



88624

If a different value is detected, slacken the nut (3) and rotate the tie rod (4) as required.

Changing the pressure relief valve

Remove the fastener (2) of the tie rod on the lever (1) and take off the valve (5) from the turbocharger by pulling out the fastening screws (6).

Fit the new valve by carrying out the operations for removal in reverse order and adjust the travel of the tie rod as described under the relevant heading.

NOTE Before fitting the turbocharger on the engine, it is necessary to fill the central body with engine lubricating oil.

GARRET GT 2256 T variable geometry turbosupercharger (engine F1C E0481 B - 166 HP)

General

The variable geometry turbosupercharger consists of the following:

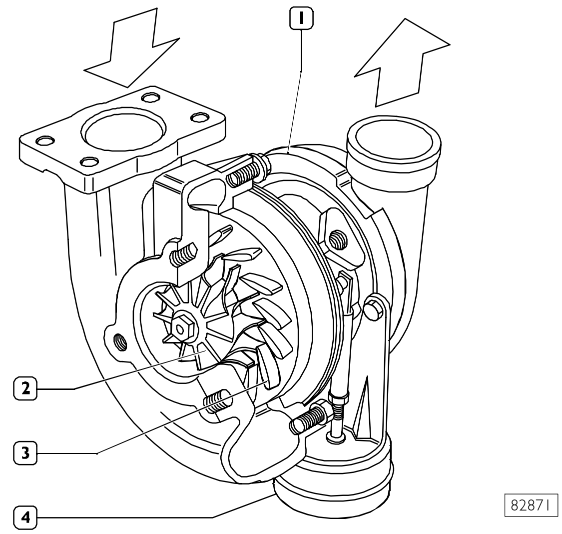
- centrifugal supercharger (1);
- turbine (2);
- set of mobile blades (3);
- mobile blade control pneumatic actuator (4), vacuum controlled by proportional solenoid valve controlled by EDC 16 ECU.

Variable geometry enables:

- to increase the speed of the exhaust gases running into the turbine at low engine rpm;
- to decrease the speed of the exhaust gases running into the turbine at high engine rpm.

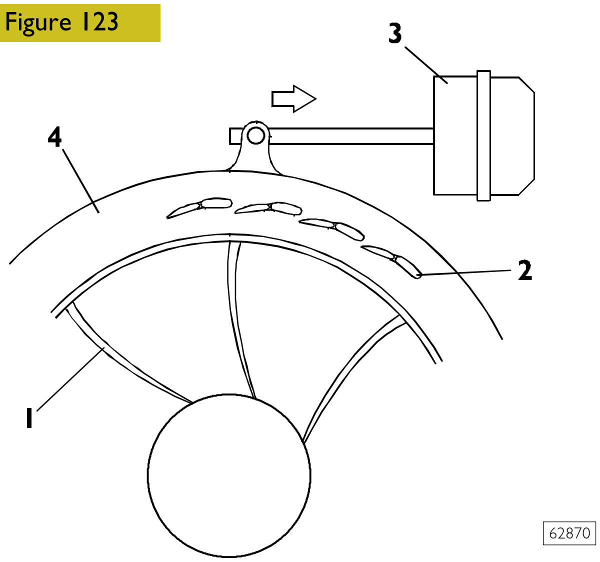
To obtain the max. engine volumetric efficiency also at low rpm (with on-load engine).

Figure 124



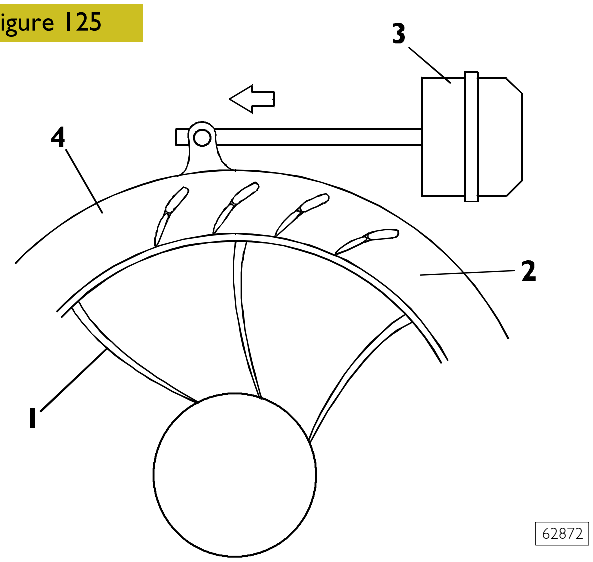
Operation at low engine rpm

Figure 123



Operation at high engine rpm

Figure 125



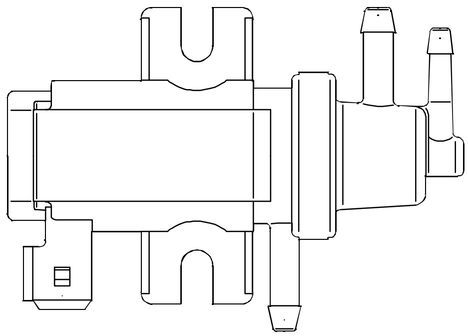
1. TURBINE - 2. MOBILE BLADES - 3. PNEUMATIC ACTUATOR - 4. REVOLVING RING

When engine is running at low speed, the exhaust gases show weak kinetic energy; under these conditions a traditional turbine shall rotate slowly, thus providing a limited booster pressure.
In the variable geometry turbine (1), the mobile blades (2) are set to max. closed position and the small through-sections between the blades increase the inlet gas speed. Higher inlet speeds involve higher tip speeds of the turbine and therefore of the turbosupercharger.
Engine speed increase results in a gradual increase of exhaust gas kinetic energy, and also in turbine (1) speed and booster pressure increase.

The ECU, through the actuator control solenoid valve, modulates the vacuum acting on the diaphragm, so actuator (3) controls through the tie rod, the gradual opening of the mobile blades (2) until reaching the max. open position.
Blade through-sections results larger thus producing a speed decrease in exhaust gas flow through the turbine (1) with speeds equal to or lower than those of the low rpm condition.
Turbine (1) speed is therefore adjusted to a proper value enabling suitable engine operation at high speeds.

Proportional solenoid valve controlling turbocharger actuator

Figure 126

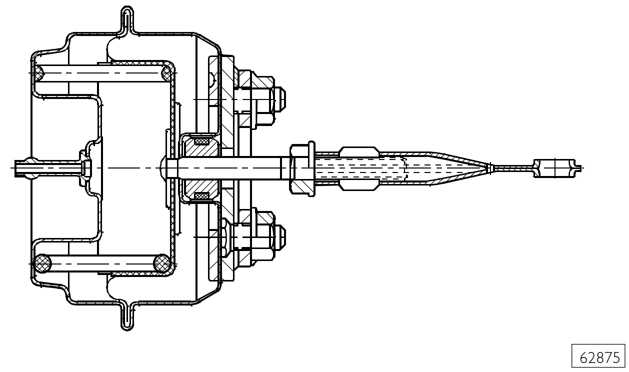


The solenoid valve modulates the low pressure controlling the turbocharger actuator, taken from the air circuit of the servo brake, according to the information exchanged between the electronic control unit and the sensors: engine speed, throttle pedal position and pressure/temperature fitted on the intake manifold.

As a result, the actuator varies the opening of the blades of the turbocharger that adjust the flow of exhaust gases.

Actuator

Figure 128

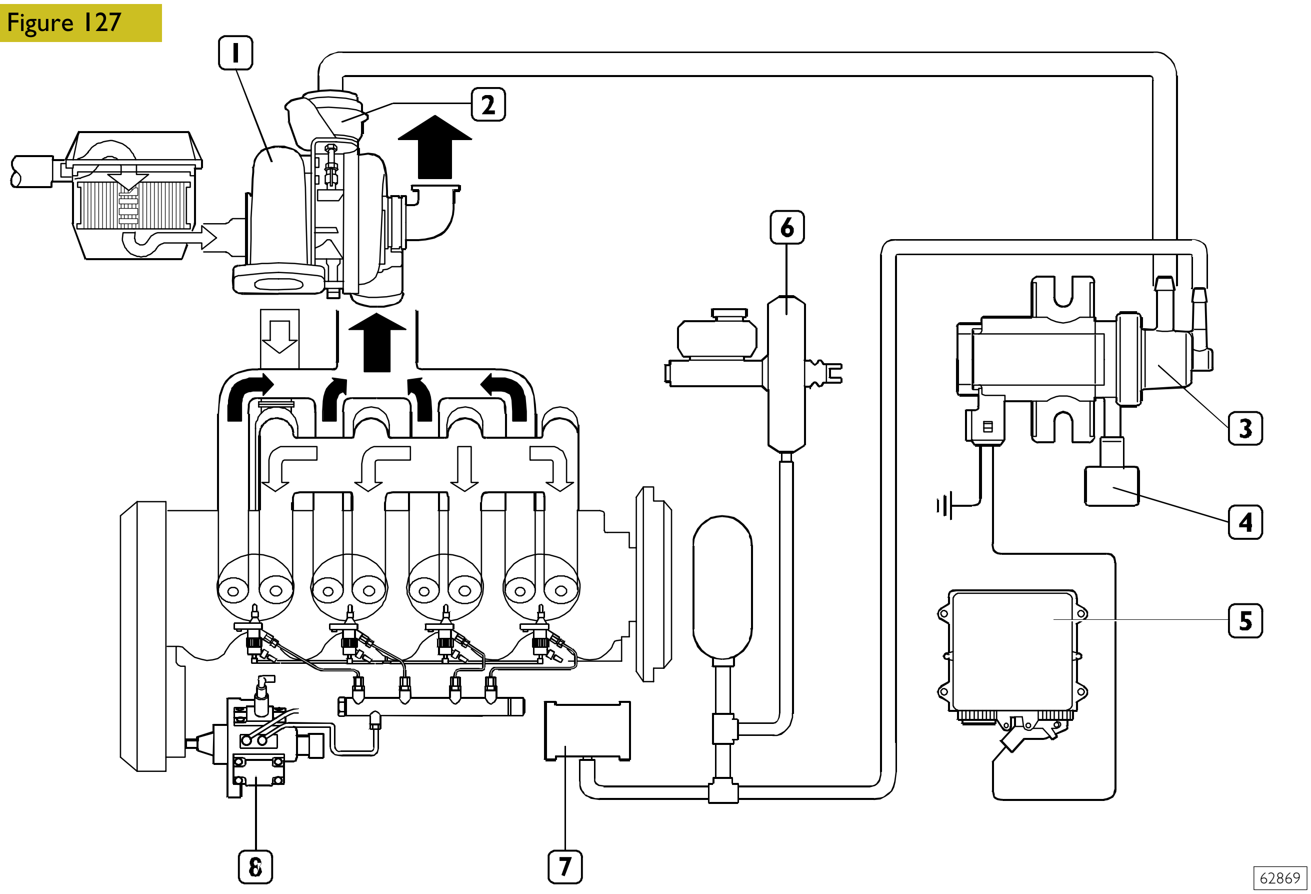


SECTION ON THE ACTUATOR

The actuator diaphragm, connected to the control rod, is governed by the low pressure on the top of the actuator.

The low pressure modulated by the proportional solenoid valve varies the movement of the diaphragm and, as a result, of the rod governing the turbine's mobile blades.

Figure 127



TURBOCHARGING FUNCTIONAL DIAGRAM

1. Variable geometry turbocharger - 2. Pneumatic actuator - 3. Proportional solenoid valve - 4. Air filter - 5. EDC 16 control unit - 6. Servo brake - 7. Vacuum device - 8. High-pressure pump.

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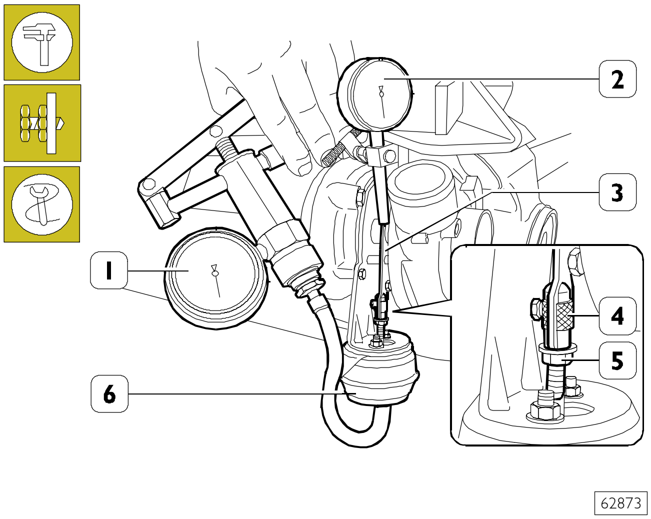
Checking and adjusting the actuator

Figure 129



Cover air, exhaust gas and lubricant inlets and outlets.

Clean the turbosupercharger outside accurately using anticorrosive and antioxidant fluid and check the actuator (6).

Clamp the turbosupercharger in a vice.

Apply vacuometer 99367121 (1) pipe to actuator (6) hose.

Apply the magnetic base gauge (2) to exhaust gas inlet flange in the turbine.

Set gauge (2) feeler pin on tie rod (3) end and set gauge (2) to zero.

Operate the vacuum pump and check whether the tie rod (3) stroke values correspond to the vacuum values shown in the following table:

- vacuum 0 mm Hg	Fully open valve
- vacuum 180 mm Hg	Valve stroke 2.5 mm
- vacuum 450 mm Hg	Valve stroke 10.5 mm

If a different value is found, loosen nut (5) and operate on the knurled ring nut (4) as required.

Once the adjustment has been carried out, tighten the nut (5) to torque 5.6 ÷ 6.8 Nm.

NOTE During the check the vacuum value shall not fall, otherwise the actuator shall be replaced.

NOTE **NOT ALLOWED ARE:**

- ❑ **any replacement or regulation of the actuator, since the calibration of such component is made in an optimal way for each turbocharger and is guaranteed for the turbocharger;**
- ❑ **any operation on nut (5) and ring nut (4), since such operation does not change engine supply characteristics but may impair engine reliability and duration.**

Ring nut (4) is sealed with antitempering yellow paint.

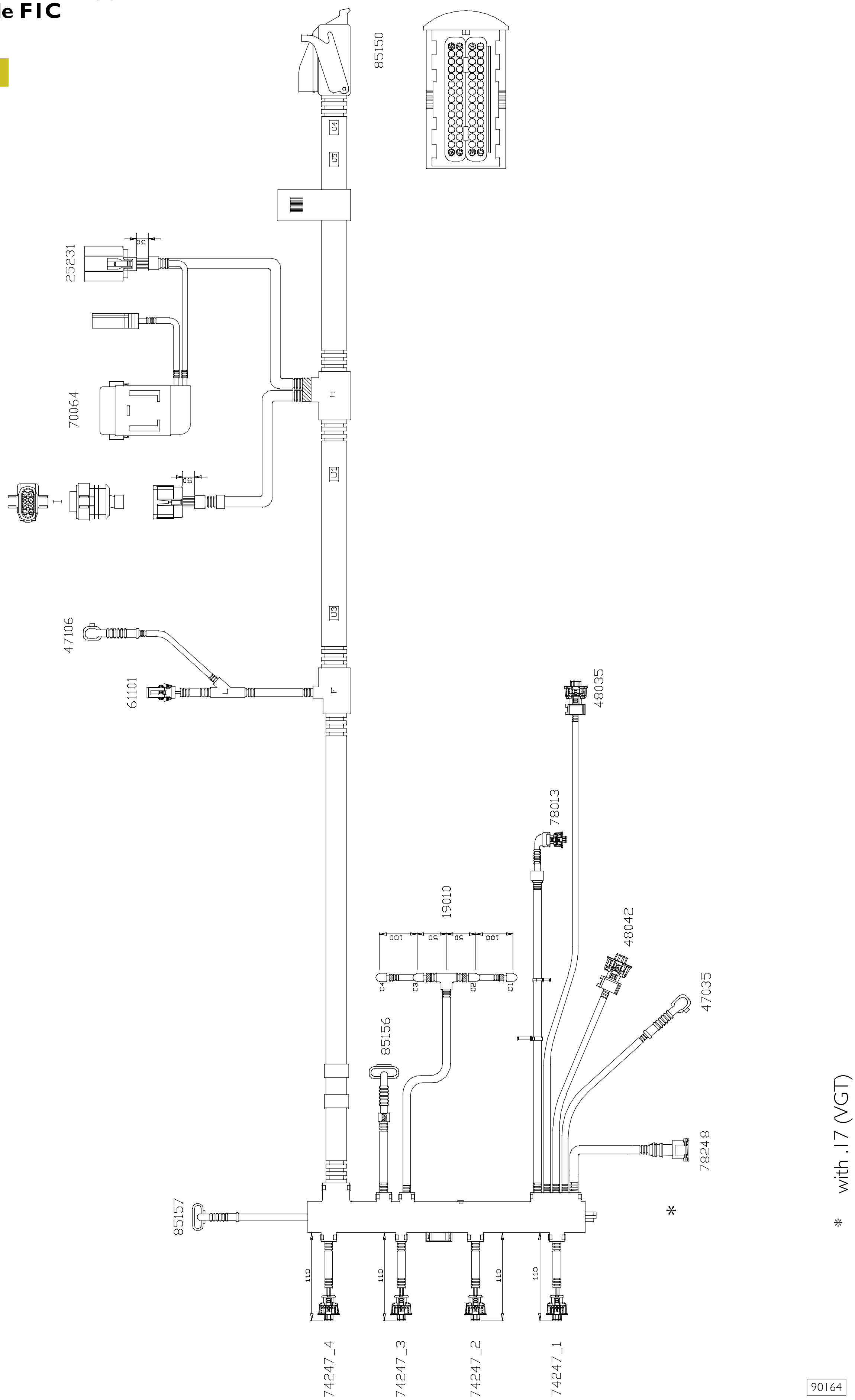
In case of engines under guarantee, each above specified intervention and/or alteration to paint applied on ring nut (4) causes the lapse of the guarantee.

PART TWO -

ELECTRICAL EQUIPMENT

F1C ENGINE HARNESS
Injection cable F1C

Figure 1



Component code	Description
85150	EDC center
1	Connections with frame cable
47035	Coolant temperature sensor
85157	Fuel pressure sensor
78247	Electrical injection electro valve
48042	rpm sensor on distributor
48035	Engine rpm sensor
78013	Pressure adjustment electro valve
47106	Fuel heat on switch
85156	EDC blower air pressure sensor
61101	Fuel heat resistor
19010	Preheat plug
25231	Plug insert centre
70064	1-way fuse holder
78248	Solenoid valve VGT (if available)

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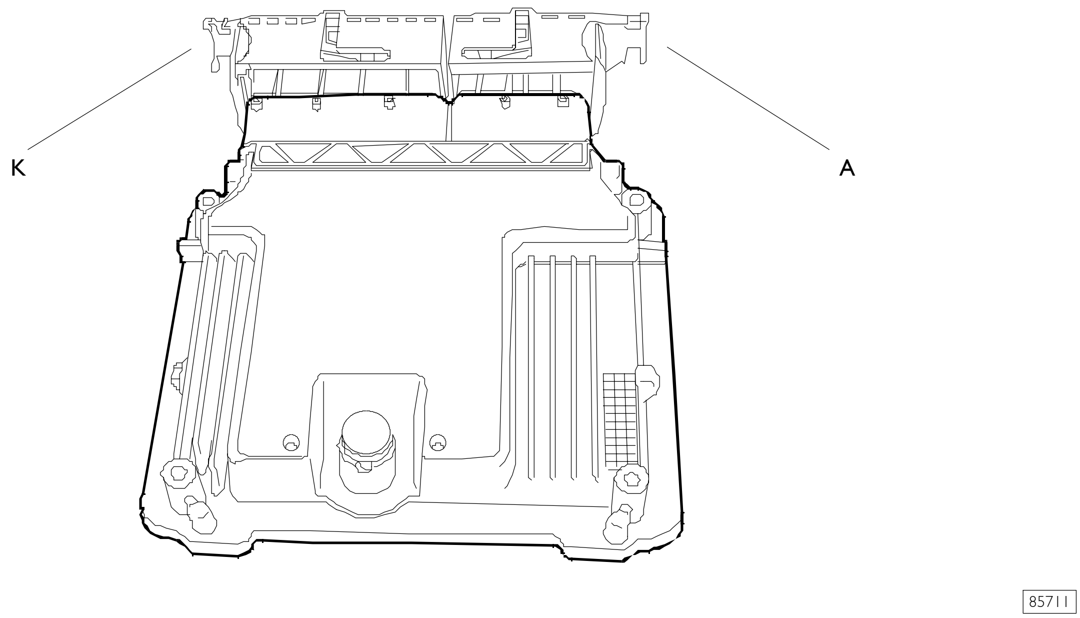
Bosch EDC16 control unit

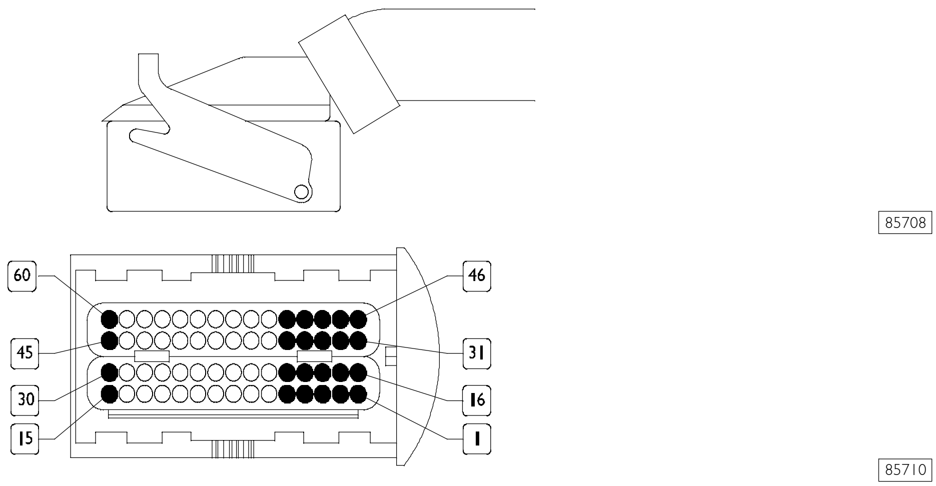
Figure 2



PERSPECTIVE VIEW
A. Engine side injection cable connector - K. Bonnet/cab cable connector.

EDC 16 control unit connection to the injection cable on engine side (housing A)

Figure 3



Pin	Cable colour code	Function
1	0000	Cylinder injector 3
2	0000	Cylinder injector 2
8	0000	Rail pressure sensor negative
11	0174	Distributing shaft sensor negative (phase)
12	red	Drive shaft sensor
13	5153*	Boosting air pressure and temperature sensor power supply
16	9924	Cylinder injector 1
17	9924	Cylinder injector 4
19	0000	Pressure regulator negative
20	7158	Distributing shaft sensor positive
21	–	Drive shaft sensor braided wire
23	0165	Boosting air pressure and temperature sensor negative
27	white	Drive shaft sensor
28	5591	Rail sensor power supply
31	9924	Cylinder injector 2
33	0000	Cylinder injector 4
40	5152*	Boosting air pressure sensor signal
41	0150	Water temperature sensor negative
43	5591	Rail pressure signal
46	9924	Cylinder injector 3
47	0000	Cylinder injector 1
49	9925	Pressure regulator
50	9160	Distributing shaft sensor signal (phase)
51	0150	Fuel temperature sensor negative

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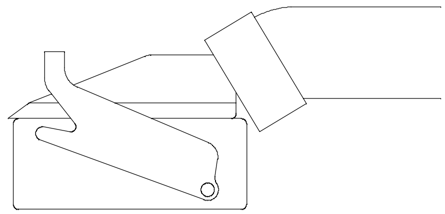
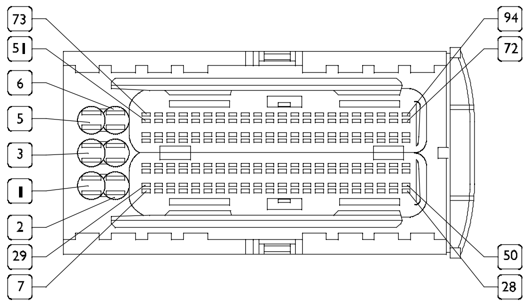
Pin	Cable colour code	Function
52	**5592**	Fuel temperature sensor signal
53	**5151***	Boosting air temperature sensor signal
58	**5154**	Water temperature sensor signal
●	Power seats	
○	Signal seats	
-	Pins not highlighted are not used	

EDC 16 control unit connection to cab-bonnet cable (housing K)

Figure 4



85708



85709

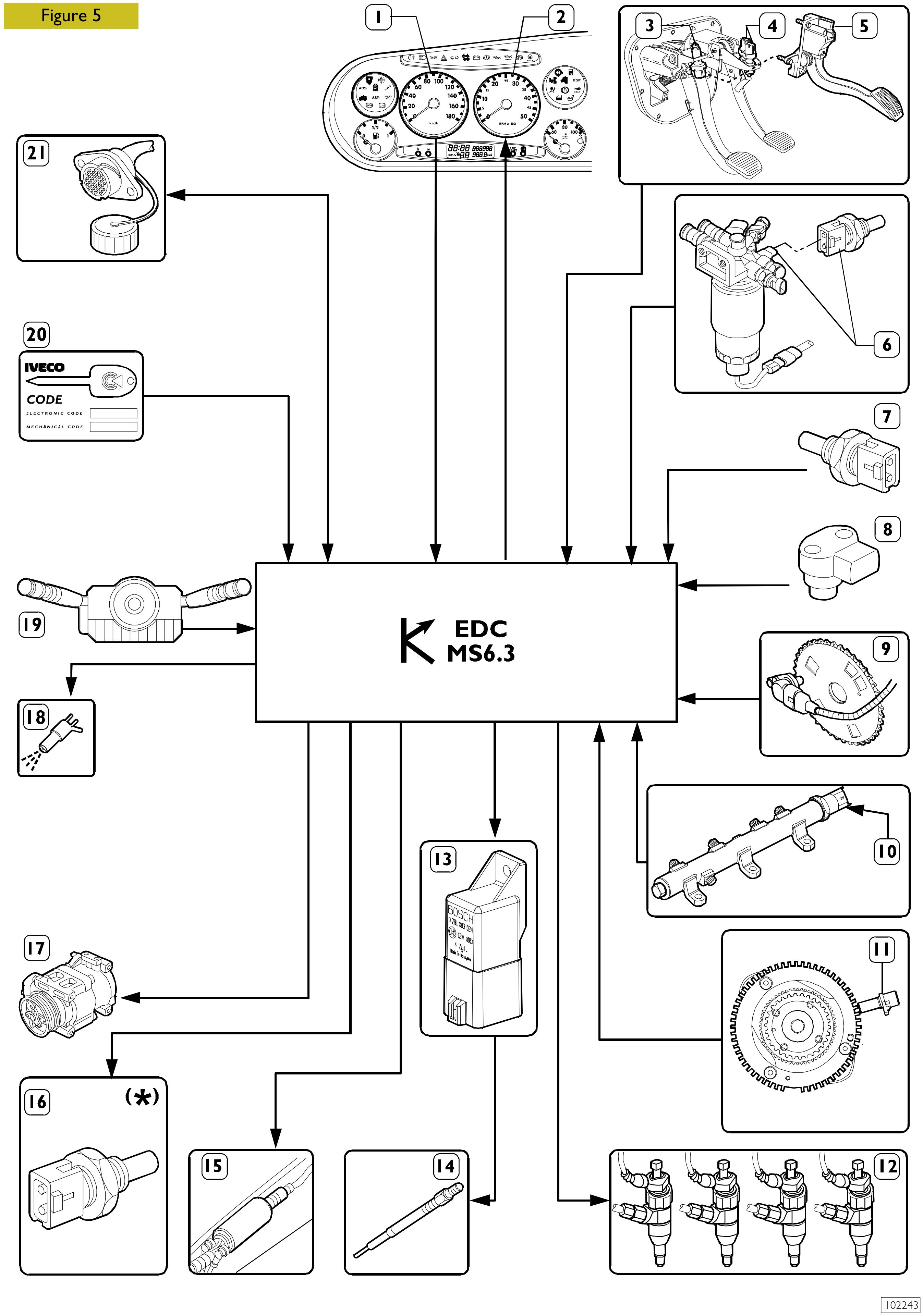
Pin	Cable colour code	Function
1	-	+30 (main relay)
2	0000	Earth
4	0000	Earth
5	8150	+30 (main relay)
6	0000	Earth
8	0150	Accelerator pedal sensor negative (pin 5)
9	5157	Accelerator pedal sensor signal (pin 4)
13	-	Signal from power takeoff (if any) state selector
16	-	Negative from power takeoff (if any) state selector
17	-	Signal from brake pedal pressed for stop light ignition
25	2299	K line
28	8051	+15
30	0159	Accelerator pedal sensor negative (pin 3)
31	5157	Accelerator pedal sensor signal (pin 6)
38	8155	Cruise Control (resume) (where available)
42	-	Speed limiter button
45	5158	Accelerator pedal sensor power supply (pin 2)
46	5158	Accelerator pedal sensor power supply (pin 1)
48	5614	Engine speed sensor (revs counter)
52	1310	To preheating spark plug actuation remote-control switch pin D1
54	8162	Signal from air-conditioning ON compressor remote-control switch
56	8157	Cruise Control (set +) (where available)
57	-	Auxiliary speed limiter (where available)
58	-	Signal from clutch switch
61	-	CAN L line
62	-	CAN H line
68	8150	Fuel filter heating remote-control switch positive

Pin	Cable colour code	Function
70	**9990**	Positive to the remote-control switch for engine water recirculation shut-off solenoid valve control with auxiliary heater ON
71	**5156**	EDC warning light negative
72	**8150**	Main relay (negative)
75	**5155**	Vehicle speed signal (tachometer)
77	**8154**	Cruise Control (off) (where available)
78	**8156**	Cruise Control (set -) (where available)
80	**8158**	Brake pedal signal
90	**7740**	Positive for engine cooling electromagnetic joint control (where available)
91	**-**	Fuel electric pump remote-control switch negative
92	**0000**	Pre-heating warning light negative
93	**1311**	To pre-heating spark plug actuation remote-control switch pin ST
-	Pins not highlighted are not used	

EDC system main components

Ref.	Component code	Description
1	58918	Tachometer on control board
2	58918	Engine speed indicator
3	42374	Clutch pedal switchgears
4	53565	Brake pedal switchgears
5	85152	Accelerator pedal position sensor
6	47106	Fuel temperature sensor
7	47035	Coolant temperature sensor
8	85156	Pressure and air temperature sensor
9	48042	Camshaft sensor
10	85157	Fuel pressure sensor
11	48035	Driving shaft sensor
12	78247	Electro-injectors
13	25231	Pre/Post Heater glow plugs electronic control unit
14	19010	Pre/Post Heater glow plug
15	85151	Fuel motor pump
16	78013	Cooling system pressurization sensor (ON/OFF)
17	12012	AC compressor
18	58701	EDC Pilot light
19	54032	Cruise Control controls /PTO (If available)
20	85130	Ignition key with immobiliser
21	72027	Diagnostic socket

Figure 5


1
2
3
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12
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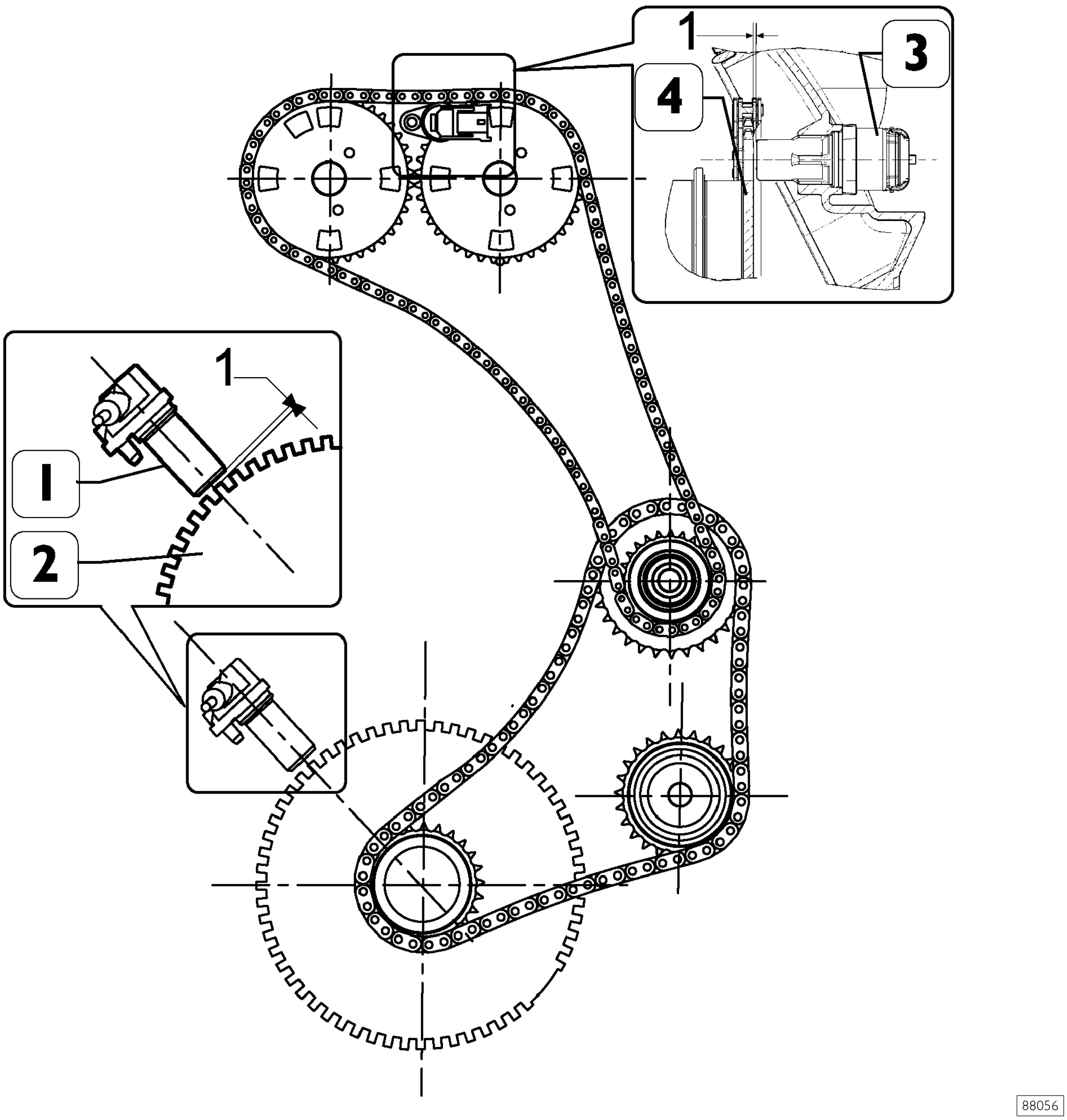
14
15
16
(*)
17
18
19
20
21
IVECO
CODE
EDC
MS6.3
102243

Driving shaft and camshaft unit

Figure 6



1. R.p.m. sensor - 2. Phonic wheel on drive shaft - 3. Timing sensor - 4. Phonic wheel on camshaft.

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Camshaft revolution sensor

A semiconductor layer, immersed in a magnetic field and through which current flows, generates a potential difference (called Hall voltage) at its ends.

If current intensity remains constant, the generated voltage depends only on the magnetic field strength: periodical variation of field strength is enough to obtain a modulated electric signal.

The smooth portion of the phonic wheel (distributing shaft pulley) covers, while moving, the sensor, thus blocking the magnetic field with resulting low output signal.

On the contrary, the sensor generates a high signal next to the openings and when a magnetic field is available.

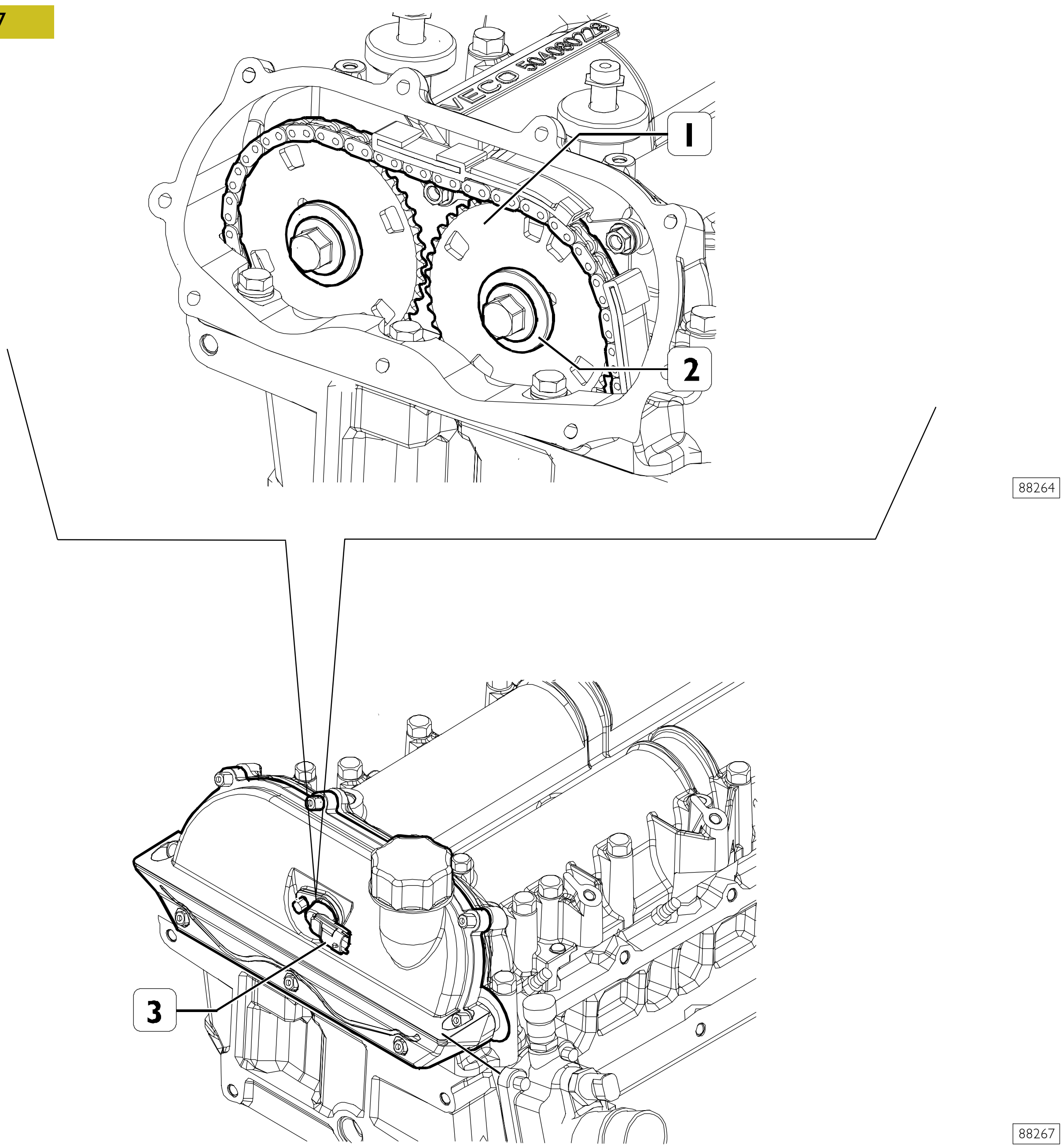
Phase sensor signals are acquired, and the engine position is recognized according to the sequence of the phonic wheel notches.

The mounting function makes it possible to identify signal errors and interferences (if any).

The resulting signal is supplied to the processor that controls the injection system.

The sensor (48042) is connected to the central unit at pins A20/50/11.

Figure 7



1. Phonic wheel on camshaft - 2. Identification slots - 3. Sensor.

Driving shaft revolution sensor

A phonic wheel is fitted on the drive shaft. As the sensor detects existing teeth passing, it provides the central unit with the signal that is necessary to determine engine r.p.m.'s.

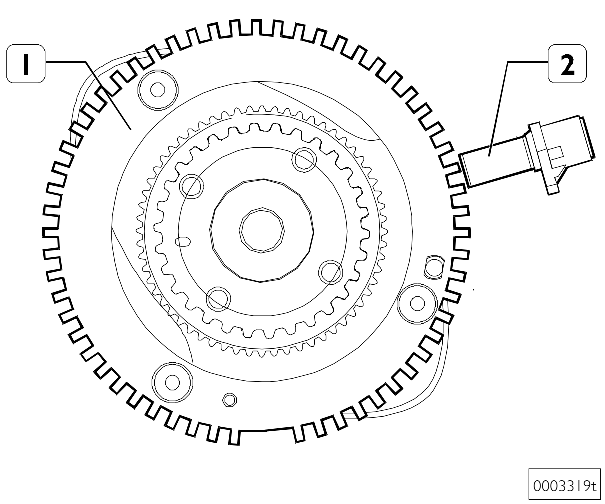
The variation of the signal generated by the lack of some teeth (synchronisation gap) occurring at each drive shaft turn is the reference signal which enables the central unit to detect the lead of the pair of pistons 1-4 with respect to PMS.

This signal is also used by the control unit to detect the engine rotation speed, the duration of injection and to control the rev counter.

This is an inductive sensor.

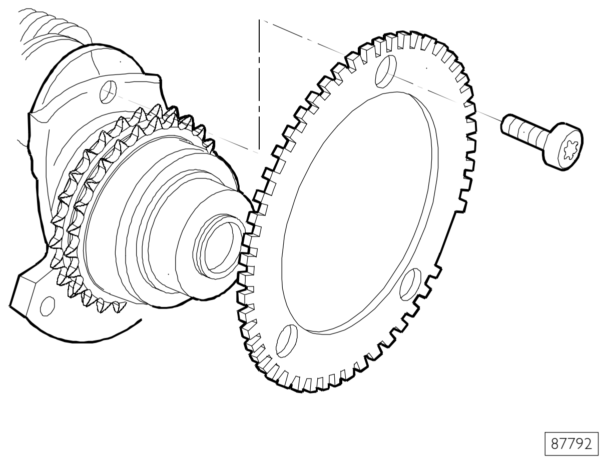
The sensor (48035) is connected to the pins No 27 and 12 of the connector A in the electronic control unit.

Figure 8



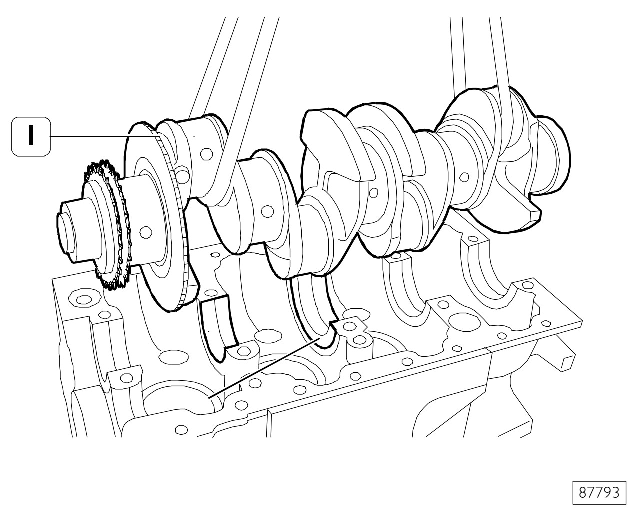
TECHNICAL VIEW OF THE SOUND WHEEL AND SENSOR
1. Sound wheel - 2. Sensor.

Figure 9



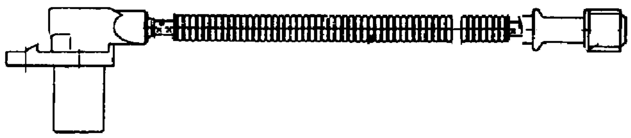
PHONIC WHEEL MOUNTING

Figure 10



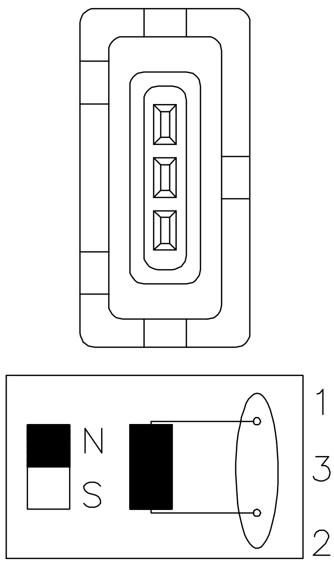
1. Phonic wheel.

Figure 11



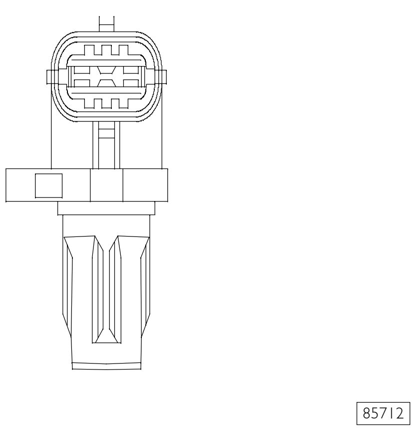
RPM SENSOR AND CONNECTION CABLE

Figure 12



SENSOR CONNECTOR AND WIRING DIRAGRAM

Figure 13



TIMING SENSOR
1. Earth - 2. Signal output - 3. Power supply positive.

Pressure regulator

It is mounted on the low pressure circuit of pump CP3.

When the engine control centre pilots the pressure regulator via the PWM signal, solenoid (1) is activated, which in its turn generates movement of magnetic core (2).

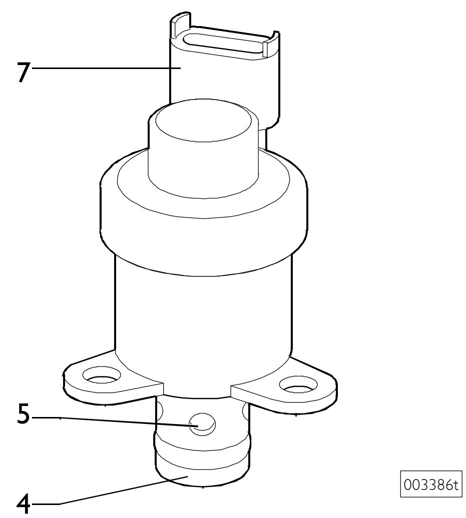
Core movement causes cylinder (3) axial displacement by fuel delivery partialization.

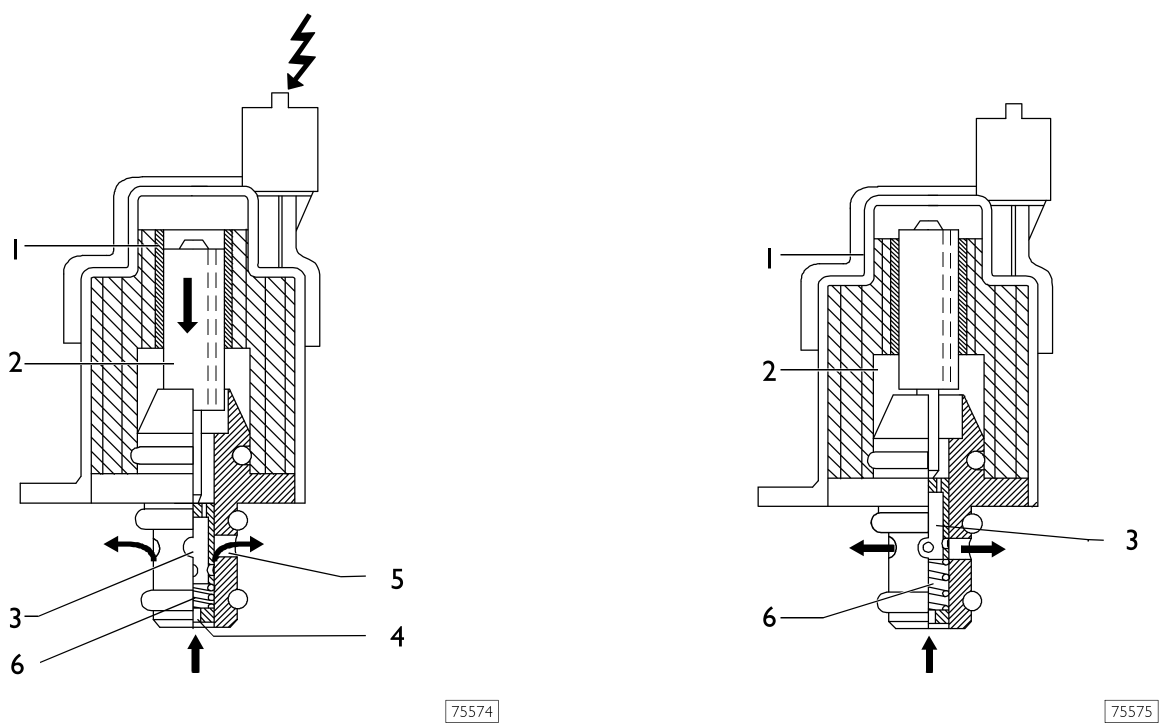
When solenoid (1) is not activated, the magnetic core is moved to its rest position by preload spring (6).

In these conditions, cylinder (3) is in a position to offer maximum fuel passage cross-section.

Drive solenoid valve (78013) is connected to pins 19 and 49 of connector A of central unit EDC 16.

Figure 14





1. Solenoid - 2. Magnetic core - 3. Cylinder - 4. Fuel input - 5. Fuel output - 6. Preloiad spring - 7. Connector.

Fuel pressure sensor (Rail)

Fitted to a rail end, it measures fuel pressure present to the purpose of determining existing fuel pressure. Pressure value is used to control pressure and determine injection electric control duration (85157).
It is connected to the central unit at pins A 8/43/28. It is fed at 5 V.

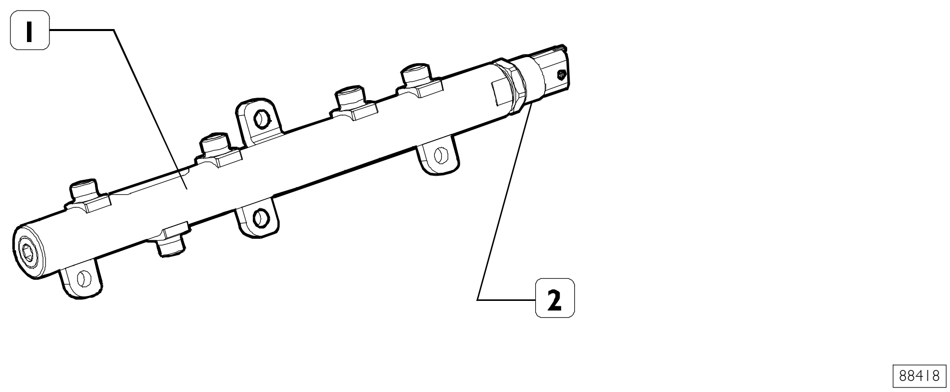
The hydraulic accumulator is mounted in the cylinder head on the side opposite aspiration.

By its volume, it damps fuel pressure oscillations owing to:

- ❑ high-pressure pump operation
- ❑ electro injector opening.

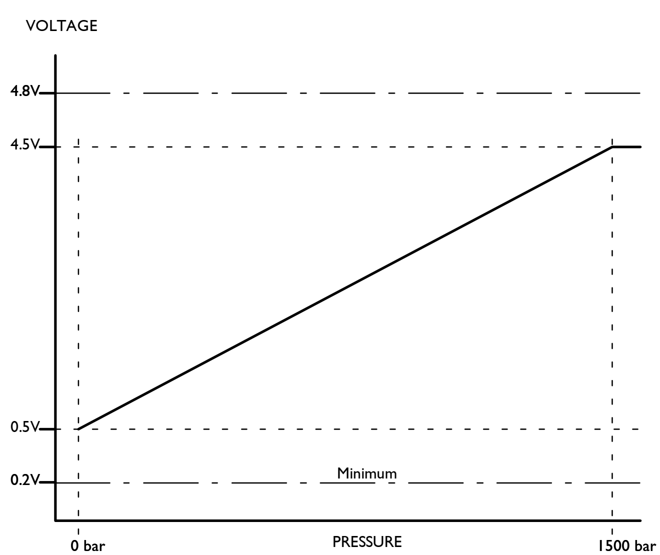
On hydraulic accumulator there is located the fuel pressure sensor.

Figure 15



1. Rail - 2. Pressure sensor.

Figure 16



PRESSURE LIMITER OPERATING GRAPH

Injectors

The solenoid valve controls the lift of the atomiser needle.

On the fuel inlet union a filter protects the injector for impurities. The injector is constructively the same as conventional ones, except that there is no needle return spring.

Access to the injectors is gained by releasing the side soundproof cover from the cylinder head. The fuel recovery pipe has a quick coupling.

The injector comprises two parts:

actuator - atomiser composed of pressure rod (1), pin (2) and nozzle (3)

control solenoid valve comprising a coil (4) and drive valve (5).

1st phase: rest position

The coil (4) is not activated and the shutter (6) is in the closed position.

The same fuel pressure acts in both the control area (7) and in the pressure chamber (8), but as the shutter (6) is closed, the needle (2) cannot be raised.

2nd phase: start of injection

The coil (4) is energised and causes the shutter (6) to move upwards.

The fuel of the control volume (9) flows towards the backflow duct (10) causing a drop in the pressure in the control area (7).

At the same time, the pressure of the fuel in the pressure chamber (8) causes the needle (2) to rise, resulting in fuel injection to the cylinder.

3rd phase: end of injection

The coil (4) is not activated and makes the shutter (6) return to the closed position, which re-creates a balance of forces that makes the needle (2) return to the closed position and consequently end injection.

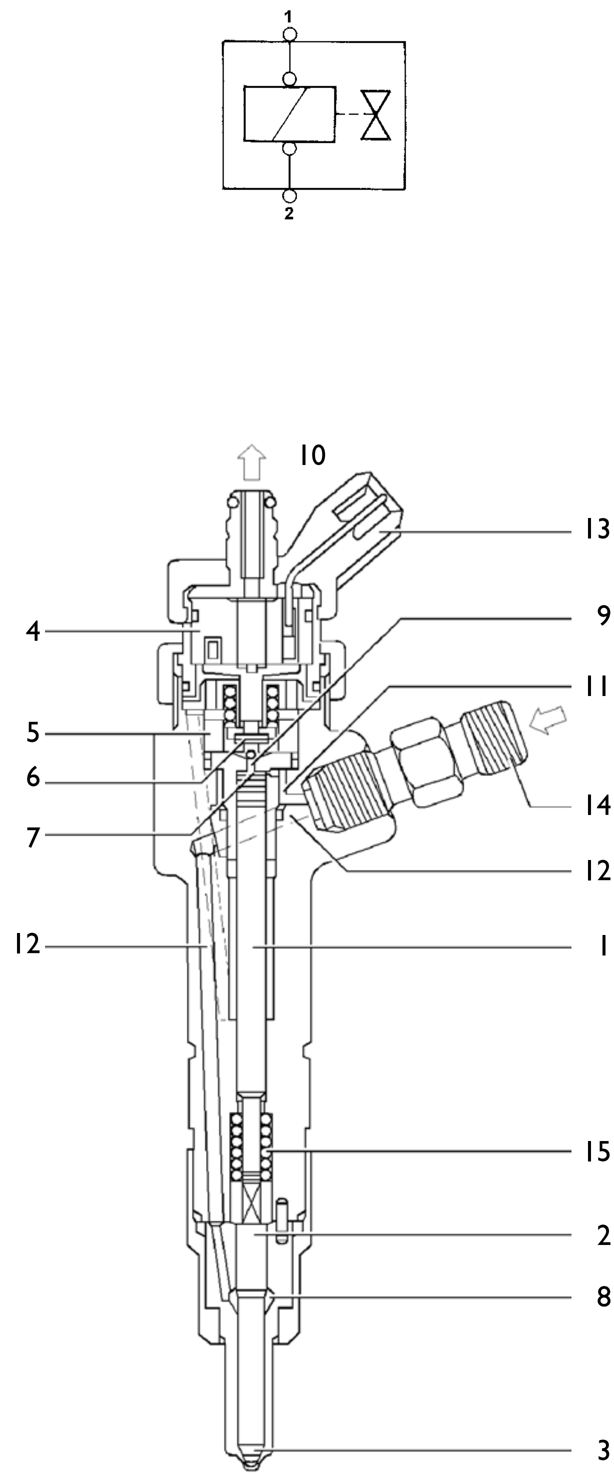
Injectors (78247)

The solenoid valve is of the N.C. type.

The injectors are connected individually to the control unit at the following pins:

- A16 / A47 cylinder 1 injector
- A2 / A31 cylinder 2 injector
- A1 / A46 cylinder 3 injector
- A17 / A33 cylinder 4 injector

Figure 17



INJECTOR WIRING DIAGRAM AND CROSS SECTION
1. Pressure rod - 2. Needle - 3. Nozzle - 4. Coil - 5. Pilot valve - 6. ball shutter - 7. control area - 8. pressure chamber - 9. Control volume - 10. Backflow duct - 11. Control duct - 12. Supply duct - 13. Electrical connection - 14. High pressure fuel inlet - 15. Spring.

Airflow gauge

This component incorporates a temperature sensor and a pressure sensor (85156).

It is fitted on the engine intake manifold and measures the maximum flow rate of the intake air which is used to accurately calculate the amount of fuel to be injected at each cycle.

It is connected to the central unit on connector "A".

Pin 1 sensor - Pin A23	-	earth -
Pin 2 sensor - Pin A53	-	temperature signal
Pin 3 sensor - Pin A13	-	5V - supply -
Pin 4 sensor - Pin A40	-	0 ÷ 5V pressure signal

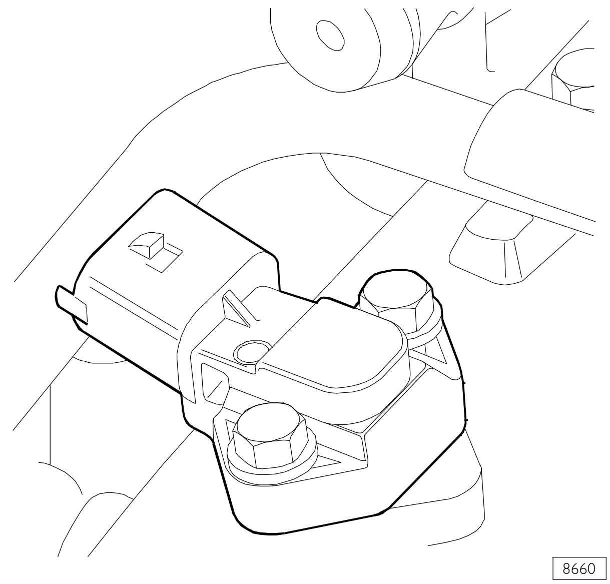
Course of sensor in relation to the temperature

Temperature	Resistance
- 40 °C	48.50 kOhm
- 20 °C	15.67 kOhm
0 °C	5.86 kOhm
20 °C	2.50 kOhm
40 °C	1.17 kOhm
60 °C	0.59 kOhm
80 °C	0.32 kOhm
100 °C	0.18 kOhm
120 °C	0.11 kOhm

Course of sensor in relation to the pressure:

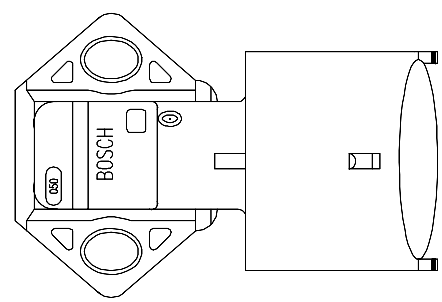
See graph opposite.

Figure 18



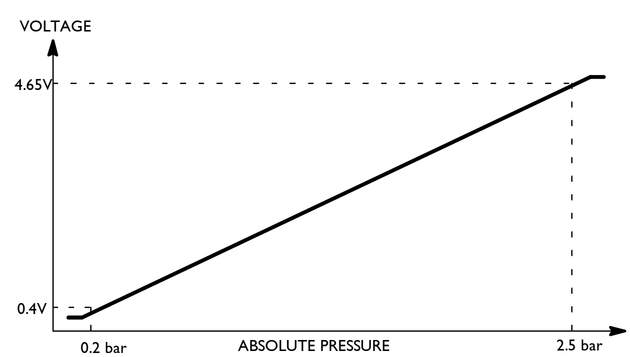
AIR FLOW METER

Figure 19



AIR FLOW METER CONNECTION

Figure 20



AIR FLOW METER OPERATING GRAPH

Atmospheric pressure sensor

This is integrated inside the control unit.

It measures the atmospheric pressure to correct the flow rate in relation to the altitude.

Engine coolant temperature sensor

This is an NTC sensor located on the thermostat box.

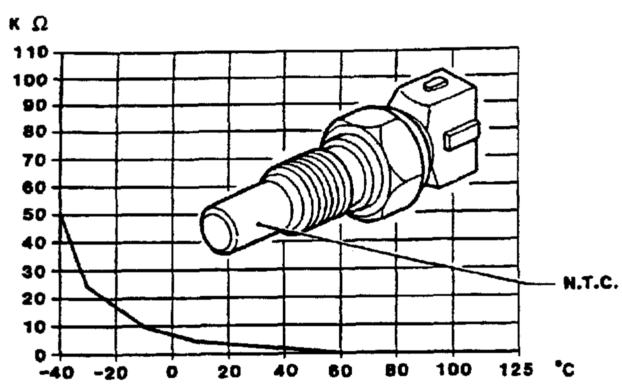
It detects the temperature of the coolant fluid to give the control unit information about the engine temperature conditions.

It is connected to pins 58 and 41 of connector A of central unit EDC 16.

Course of the sensor in relation to the temperature:

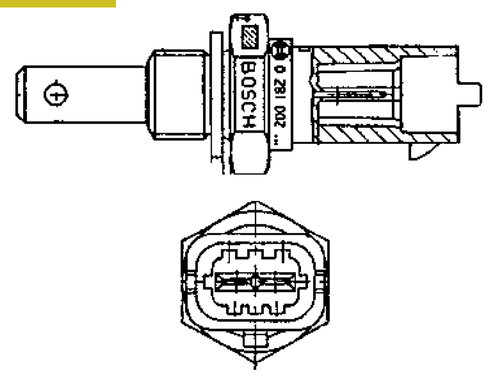
Temperature	Resistance
- 40°C	48.30 kOhm
- 20°C	15.46 kOhm
0°C	5.89 kOhm
20°C	2.50 kOhm
40°C	1.17 kOhm
60°C	0.59 kOhm
80°C	0.32 kOhm
100°C	0.19 kOhm
120°C	0.11 kOhm

Figure 21



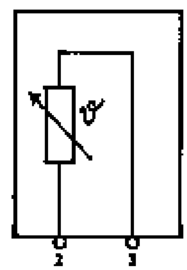
COURSE OF SENSOR RESISTANCE IN RELATION TO TEMPERATURE

Figure 22



TECHNICAL VIEW OF ENGINE COOLANT TEMPERATURE SENSOR

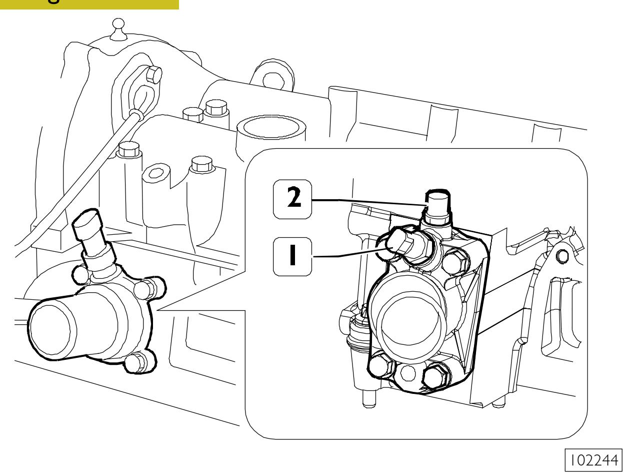
Figure 23



NTC

WIRING DIAGRAM

Figure 24



LOCATION OF F1C ENGINE COOLANT TEMPERATURE SENSOR
1. EDC - 2. Signal instrument panel signal

Fuel temperature sensor

This is an NTC sensor located on the fuel filter.

It detects the temperature of the fuel to give the control unit information about the fuel oil temperature conditions.

It is connected to pins 51 and 52 of connector A of central unit EDC 16.

It is exactly the same as the engine coolant temperature sensor.

Preheat plug electronic centre

EDC central unit effects the timing of the functioning of glow plugs pre-heating central unit depending on engine temperature, which, in turn, activates the glow plugs.

The preheat centre contains an "intelligent" remote control switch that sends a feed-back to the control centre for information on any preheat centre defect or plug earth shirt circuit.

Preheat centre pin-out

31 - Mass
86 - Start switch (+15)
ST - EDC electronic centre (pin B42)
DI - EDC electronic centre (pin B37)
30 - Battery positive (+30)
G1 - Preheat plugs
G2 - Preheat plugs
G3 - Preheat plugs
G4 - Preheat plugs

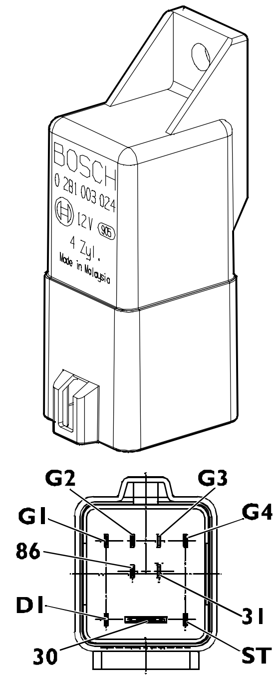
Preheat plugs

CONTROL VALUES

With constant di 11V power supply:

❑ maximum current absorbed	18 A
❑ in 5"	11 ± 1,5 A
❑ in 30"	6 ± 0.9 A
❑ temperature after 7"	850°C
❑ torque	8-10 Nm

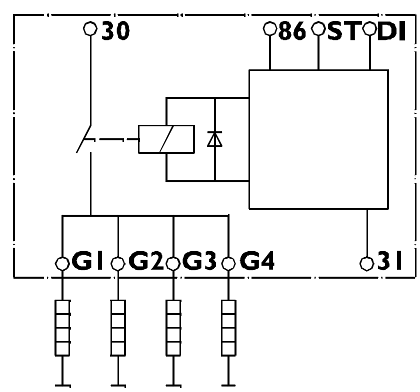
Figure 25



003332t

PREHEAT CENTRE

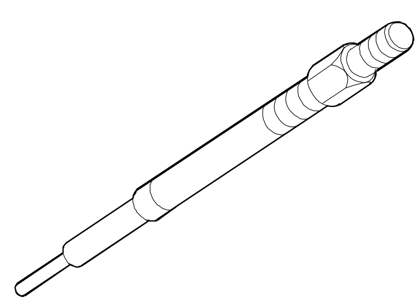
Figure 26



003331t

ELECTRICAL DIAGRAM

Figure 27



75579

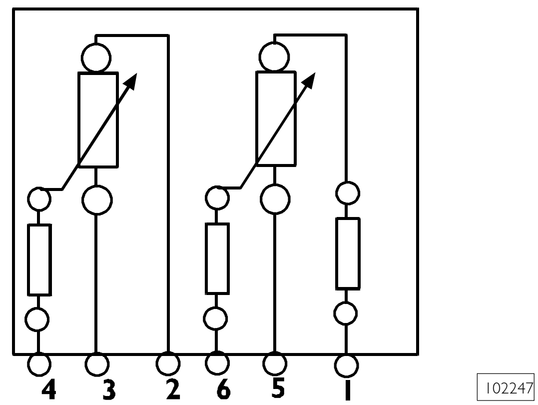
PREHEAT PLUS

Accelerator pedal sensor

A new sensor which incorporates two potentiometers (no idling switch is provided) is available on the accelerator pedal. The ratio between the signals from the two potentiometers is 2:1 (one potentiometer exhibits a twofold resistance value compared with the other). Both of these signals (V) are detected by the control unit that processes them according to stored threshold values and manages the injection system as an accelerator pedal position set by the driver. (At the output of these potentiometers, a variable voltage is available which corresponds to the potentiometer resistance value.)

It is connected for central unit EDC 16 to Pin 9-30-45-31-8-46 of connector K. The potentiometers are supplied with 5 Volt voltage provided by the central unit itself.

Figure 28



Fuel filter

Cartridge degree of filtering: 5 micron

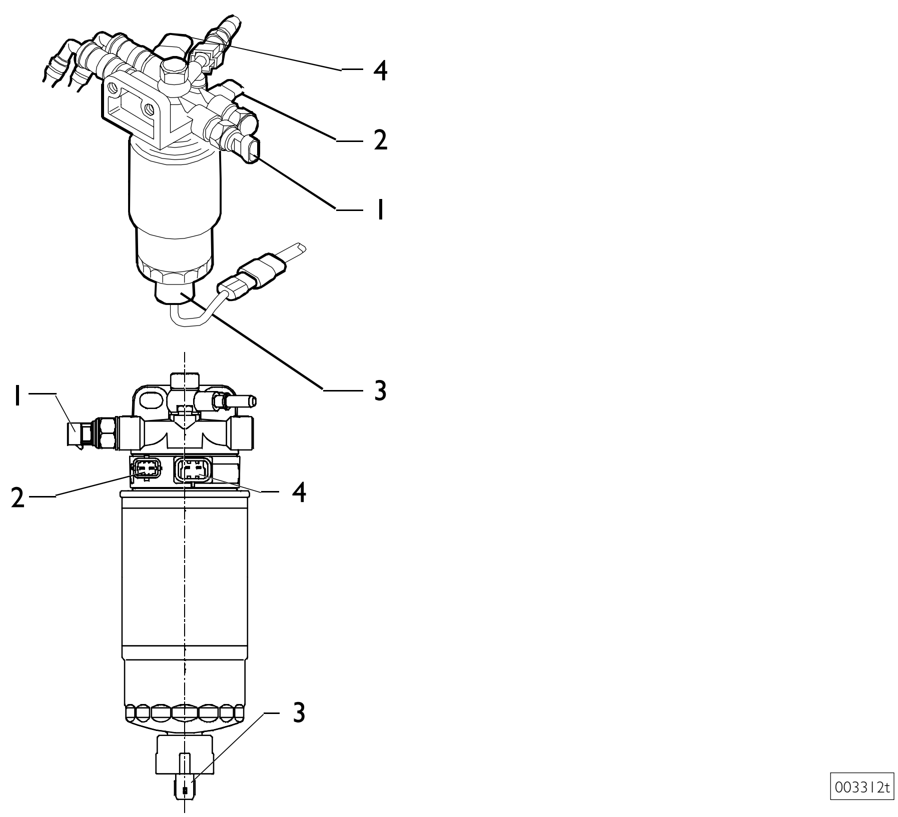
Differential operating pressure (obstruction indicator): 0.6 bar

The fuel temperature sent by the sensor to the electronic injection control unit allows very accurate calculation of the flow rate of the fuel to be injected in the cylinders.

It is located in a fairly accessible position in the left front part of the engine compartment.

1. Actuated by ECU via relay with fuel temperature below 3°C.
2. Filtering element
3. Shows presence of water through a warning lamp on instrument panel.
4. Differential pressure sensor calibrated at 0,6 bar : any clogging is shown by warning lamp
5. It is a NTC sensor connected to EDC for fuel temperature reading enabling electronic control to calculate the amount of diesel oil to be injected into the cylinders.
6. Installed on filter support for excess fuel return to tank.

Figure 29



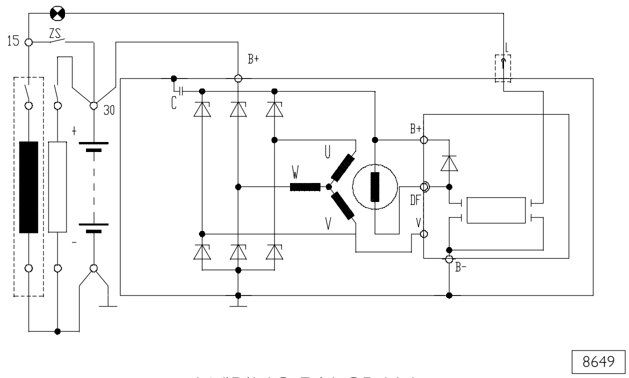
1. Clogged filter sensor - 2. Fuel temperature sensor - 3. Water sensor - 4. Heater.

MAIN COMPONENTS OF POWER NETWORK

BOSCH KCBI 14V 110A Alternator

03000

Figure 30



WIRING DIAGRAM

Specifications for use

Vehicle electric system rated voltage:	12 V

Suitable for coupling with battery of any capacity
It must work with the battery connected.

Connection with inverted polarity is not allowed.

Operating specifications

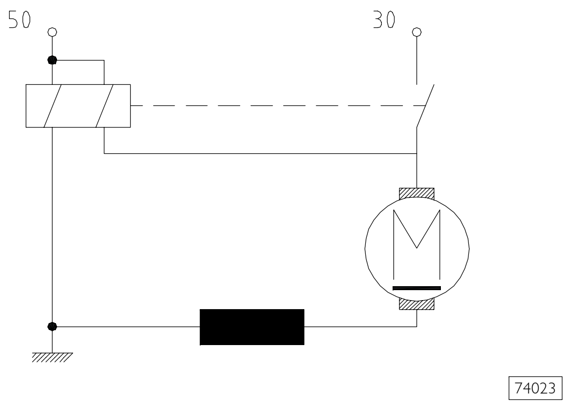
Rated voltage	14 V
Rated current delivery	110A
Drive side direction of rotation	clockwise
Maximum continuous speed	≤ 12.000 min^{-1}
Storage temperature	-40 °C / +110 °C

Figure 31

REAR VIEW FRONT VIEW

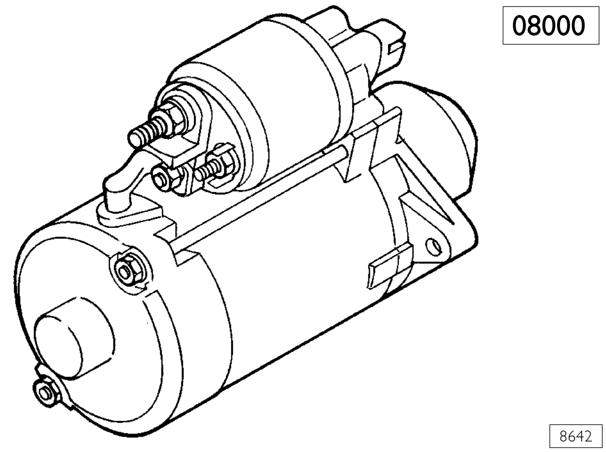
EV 12V - 2.3 kW Starter motor

Figure 32



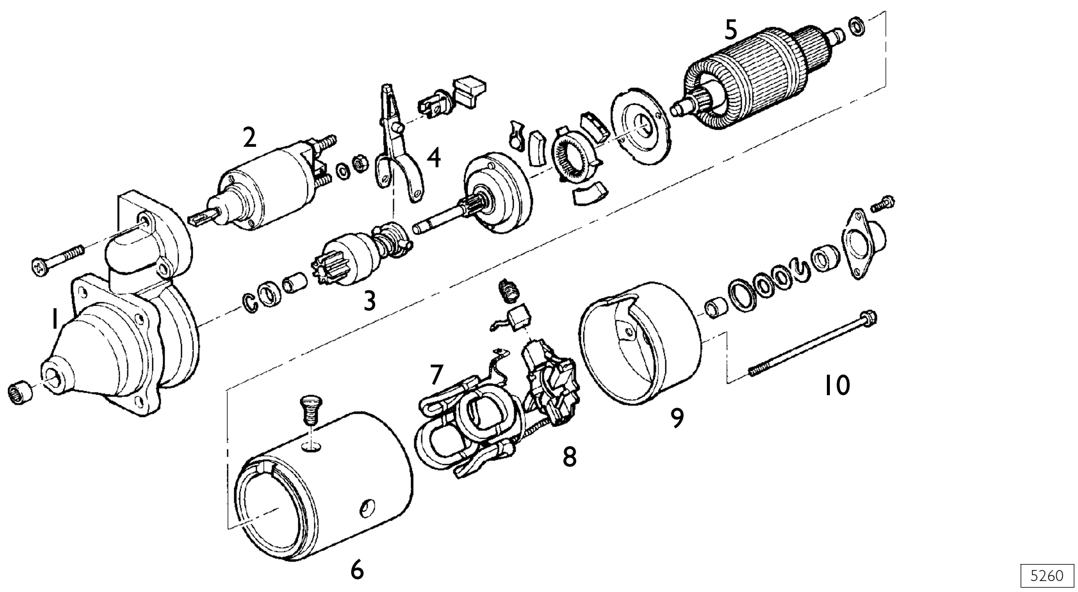
WIRING DIAGRAM

Figure 33



PERSPECTIVE VIEW

Figure 34



PERSPECTIVE BLOWN-UP VIEW
1. Support - 2. Pinion engagement control electromagnet - 3. Pinion - 4. Pinion engament fork - 5. Rotor - 6. Frame - 7. Inductors - 8. Brush holder support - 9. Cover - 10. Screw.

Fast diagnosis

Defect	Possible causes	Remedy
Low drawing torque	1. Low battery	Recover
	2. Oxidized or loose circuit connections	Check starter motor and battery connections
	3. Faulty brushes	Check brush slide length and pressure
	4. Field coils short circuited	Replace coils
	5. Rotor cut out or short circuited	Replace rotor
	6. Oval collector	Grind correct or replace
Low drawing torque but engine does not start	1. Defective free wheel or electromagnet	Replace
Pinion disconnected	1. Worn toothed crown	Recover

SYSTEM OPERATION
Self-diagnosis – BLINK CODE

The control unit self-diagnosis system checks the signals from the sensors, comparing them with the admitted limits (see relative heading):

Immobilizer recognition (if present)

When the control unit receives the signal of the key on "MAR" it communicates with the immobilizer control unit to enable starting.

Checking fuel temperature

With the fuel temperature greater than 75°C, detected by the sensor on the fuel filter, the control unit operates the pressure regulator to decrease the line pressure (injection times are not changed). If the temperature exceeds 90°C, the power is reduced to 60%.

Checking engine coolant temperature

The control unit, depending on the temperature:

- of the engine coolant, turbocharging air and fuel, operates the electromagnetic fan (Baruffaldi) and switches on the coolant temperature warning light.

Checking quantity of fuel injected

According to the signals from the sensors and the mapped values, the control unit:

- operates the pressure regulator;
- varies the "pilot" injection time to 2200 rpm;
- varies the "main" injection time.

Checking idling adjustment

The control unit processes the signals from the various sensors and regulates the amount of fuel injected:

- it operates the pressure regulator;
- it varies the injection times of the electro-injectors.

Within certain thresholds the speed takes account of the battery voltage.

Fuel cut-off in release phase

In the phase of releasing the throttle pedal the control unit actuates the following logic elements:

- it cuts off supply to the electro-injectors;
- it partially reactivates supply to the electro-injectors before reaching idling speed;
- it operates the fuel pressure regulator.

Checking cylinder balancing on idling

According to the signals received from the sensors, the control unit controls the regularity of the torque at idling speed:

- it varies the amount of fuel injected into the single electro-injectors (injection time).

Checking regular engine rotation (anti-sawing)

It ensures regular engine rotation at a constant rate while increasing revs.
The control unit processes the signals received from the sensors and determines the amount of fuel to be injected via:

- the pressure regulator;
- the electro-injector opening time.

Checking smokiness at exhaust on acceleration

With heavy acceleration, on the basis of the signals received from the air introduction meter and engine speed sensor, the control unit determines the optimum amount of fuel to inject:

- it operates the pressure regulator;
- it varies the electro-injector injection time.

Checking exhaust gas recirculation (E.G.R. if present)

Depending on the engine load and the signal from the accelerator pedal sensor, the control unit limits the amount of air taken in, actuating partial suction of the exhaust gases.

Checking top speed limit

Depending on the number of revs, the control unit actuates two action strategies:

- at 4250 rpm it cuts off the fuel, decreasing the electro-injector opening time;
- over 5000 rpm it deactivates the electro-injectors.

Checking regular rotation on acceleration

Regular progression is assured in all conditions by the control of the pressure regulator and the electro-injector opening time.

Checking glow plug control unit

The injection control unit, in the phase of:

- starting
- after-starting

times operation of the glow plugs according to the engine temperature.

Checking activation of air-conditioning system

The control unit operates the air-conditioning compressor:

- switching it on/off when the relative switch is pressed;
- momentarily turning it off (approximately 6 sec.) if the engine coolant reaches the set temperature.

Checking fuel pump

Irrespective of the speed, the control unit:

- supplies the auxiliary fuel pump with the key on MAR;
- cuts off auxiliary pump supply if the engine is not started up within a few seconds.

Checking diesel warming

It times operation of diesel warming in relation to ambient temperature.

Checking cylinder position

During each turn of the engine, the control unit recognizes which cylinder is in the power stroke and operates the injection sequence for the appropriate cylinder.

Checking pilot and main injection timing

According to the signals from the various sensors, including the absolute pressure sensor built into the control unit, the control unit determines the optimum point of injection according to internal mapping.

Checking injection pressure closed cycle

Depending on the engine load, determined by processing the signals from the various sensors, the control unit operates the regulator to obtain optimum line pressure.

Fuel supply

The fuel supply is calculated in relation to:

- accelerator pedal position
- engine speed
- quantity of air introduced.

The outcome may be corrected in relation to:

- the water temperature.

Or to avoid:

- noise
- smoke
- overloading
- overheating
- turbine over-revving.

The delivery can be modified in the case of:

- action of external devices (ABS), ABD, EDB
- serious trouble decreasing the load or stopping the engine.

After determining the mass of air introduced by measuring its volume and temperature, the control unit calculates the corresponding mass of fuel to inject into the relevant cylinder (mg per delivery) also taking into account the temperature of the diesel.
The mass of fuel calculated in this way is first converted into volume (mm^3 per delivery) and then into degrees of throw, or duration of injection.

Correcting flow rate according to water temperature

A cold engine meets with greater resistance during operation: friction is high, the oil is still very viscous, and the various clearances are not yet optimized.
In addition, the injected fuel tends to condense on the metal surfaces that are still cold.
The fuel supply for a cold engine is therefore greater than for a warm one.

Correcting flow rate to avoid noise, smoke or overloading

The behaviour that could lead to this kind of trouble is well known.

The designer has therefore included special instructions in the control unit to avoid it.

De-rating

In the event of the engine overheating, injection is modified, decreasing the delivery to a varying degree, in proportion to the temperature reached by the coolant.

Injection timing electronic test

The advance (start of delivery, expressed in degrees) may be different from one injection to the next, also differentiated from one cylinder to another. It is calculated, similarly to the delivery, in relation to the engine load (accelerator position, engine speed and air introduced).
The advance is appropriately corrected:

- in phases of acceleration;
- according to the water temperature.

And also to obtain:

- lower emissions, noise and overloading;
- better vehicle acceleration.

An extremely high advance is set on starting, depending on the water temperature.
Feedback from the start of delivery is supplied by the change in impedance of the injector solenoid valve.

Speed governor

The electronic speed governor has both features of governors:

- idling and top speed
- all speeds

It is stable in ranges where conventional, mechanical governors are imprecise.

Engine starting

During the first few turns of the engine, the timing and cylinder no. 1 recognition signals (flywheel sensor and camshaft sensor) are synchronized.
The accelerator pedal signal is ignored on starting. Starting delivery is set only according to water temperature, by a special map.
When the control unit detects such speed and acceleration of the flywheel as to be able to consider the engine started up and no longer driven by the starter motor, it re-enables the accelerator pedal.

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Cold starting

If even just one of the three temperature sensors (water, air or diesel) records a temperature lower than 10°C, pre-post heating is activated.
When the key makes contact the pre-heating indicator light comes on and stays on for a length of time that varies in relation to the temperature (while the glow plugs in the cylinder head heat the air), then flashes. It is now possible to start up the engine.
When the motor is running this indicator light goes out, while the glow plugs continue to be powered for a certain length of time (variable) for post-heating.
If, with the indicator light flashing, the engine is not started up within 20-25 seconds (inattention time), the operation is cancelled so as not to run down the batteries pointlessly.
The pre-heating curve is also variable in relation to the battery voltage.

Warm starting

If the reference temperatures all exceed 10°C, when the key makes contact the indicator light comes on for approximately 2 sec., for a short test, and then goes out. It is now possible to start up the engine.

Run up

When the key makes contact, the control unit transfers the information stored in memory when the engine was last stopped into the main memory (see After Run) and makes a diagnosis of the system.

After run

Whenever the engine is switched off with the key, the control unit stays powered for a few seconds by the main relay.
This makes it possible for the microprocessor to transfer some data from the main memory (volatile) to a non-volatile memory, which can be erased and written over (EEPROM), so as to make it available at the next start up (see Run Up).

These data basically consist of:

- various settings (engine idling adjustment, etc.);
- settings of some components;
- fault memory.

The process lasts a few seconds, typically from 2 to 7 (depending on the amount of data to save), after which the ECU sends a command to the main relay and makes it disconnect from the battery.

NOTE It is extremely important for this procedure not to be broken off, for example by switching off the engine with the battery cut-out, or by disconnecting the battery cut-out before 10 seconds have passed since switching off the engine. If this happens, the functioning of the system is ensured, but repeated interruptions may damage the control unit.

Cut-off

This function cuts off fuel delivery when the vehicle is decelerating (accelerator pedal released).

Cylinder balancing

Individual cylinder balancing contributes to increasing comfort and handling.
This function permits individual, customized control over the delivery of fuel and the start of delivery for each cylinder, even differently from one cylinder to another, to compensate for the hydraulic tolerances of the injector.

The differences in flow (delivery specifications) between the various injectors cannot be evaluated directly by the control unit. This information is supplied by Modus reading the bar code of each injector at the time of assembly.

Synchronization search

If there is no signal from the camshaft sensor, the control unit is anyhow able to recognize the cylinders into which the fuel is to be injected.
If this occurs when the engine is already running, the combustion sequence has already been acquired, so the control unit continues with the sequence on which it has already been synchronized.
If this occurs when the machine is at a standstill, the control unit energizes a single solenoid valve. Within at most 2 turns of the crankshaft, injection will take place in that cylinder, so the control unit just needs to get synchronized on the firing sequence and to start up the engine.

PART THREE - TROUBLESHOOTING

PT-01 PORTABLE TESTER

Using PT-01 with portable tester it is possibile to execute troubleshooting and test the failure memory of the electronic module.

PT-01 has been designed and developed to ensure stoutness and practicality and is particularly suitable to be used in workshop and industrial environment.

The tool is connected to the engine gearbox by means of one only cable providing both tester feed and communication with the electronic module.

Main functions

Before connecting the tester to the electronic module, check the wording on the electronic module to select the correct software on the tool.

```
1 2 3 4 5 6 7 8 . A B C
u m m k a a * * . v a 0

        a a    software 3.3_1
        a b    software 4.1_2
```

Easy access to different functions is available through the menu:

- ID. Reading of the electronic module;
- Reading of failure memory and relevant environment conditions;
- Failure memory clear;
- Reading of working parameters;
- Reading of status parameters;
- Active troubleshooting (switching on heat starter, fuel pump, EDC warning led and so on)

Test parameters

- Engine revolutions;
- Spark advance;
- Battery voltage;
- Accelerator foot pedal position;
- Over voltage pressure;
- Over voltage air temperature;
- Cooling liquid temperature;
- Fuel temperature;
- Oil temperature;
- Oil pressure;
- Fuel delivery;
- Fuel pressure;
- Rail pressure duty cycle electro-valve.

DTC-FMI error codes with EDC central unit

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
0D	02	EGR - AIR MASS SUPPLY TOO HIGH (if present)	BELOW LOWER LIMIT	EGR off. Emissions not compliant with law. Derated performance and smoke at high engine rpm.	EGR monitoring: incorrect EGR percentage actuation calculated by ECU.	Check, if the EGR pneumatic valve is not locked in Open or Closed-Position 2) Check, that the solenoid valve and the EGR pneumatic valve is not squashed or holed or detached 3) Check the EGR solenoid valve-functionality 4) Check the solenoid valve-integrity by means of a multimeter 5) Check the wiring harness between the solenoid valve and the EDC connector.				
11	01	ENGINE 1 - BOOST PRESSURE SENSOR	EXCEEDED UPPER LIMIT	Positive power reduction and smoke in exhaust.		Check wiring and connections. Possibly replace sensor. Check in "measurable parameter" environment that atmospheric pressure sensor and turbo charger air pressure sensor values are similar when engine is off.				Possible smoke in exhaust during acceleration. Replace if required.
11	02	ENGINE 1 - BOOST PRESSURE SENSOR	BELOW LOWER LIMIT	Positive power reduction and smoke in exhaust.		Check wiring and connections. Replace sensor if required.				Possible smoke in exhaust during acceleration. Replace if required.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
11	08	ENGINE 1 - BOOST PRESSURE SENSOR	SIGNAL NOT PLAUSIBLE	Positive power reduction and smoke in exhaust.	Faulty sensor.	Check wiring and connections. Replace sensor if required.				
12	01	ENGINE 2 - BATTERY VOLTAGE	EXCEEDED UPPER LIMIT	Problematic cranking.	Flat battery, interrupted wiring.	Check battery state with diagnostic tool (measurable parameters). Check wiring and connections.				Replace alternator, regulator or battery.
12	02	ENGINE 2 - BATTERY VOLTAGE	BELOW LOWER LIMIT	Engine does not start. Possible power reduction.	Faulty battery, faulty alternator, faulty ECU.	Check with diagnostic tool.				Replace battery, alternator or ECU if required.
13	08	VEHICLE - BRAKE PEDAL SIGNAL ERROR	SIGNAL NOT PLAUSIBLE	Brake signal plausibility, possibly no brake lights, Cruise Control / PTO not working.	The two switch states are different.	Check wiring and connections. Replace sensor if required.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
14	01	ENGINE 1 - COOLANT TEMPERATURE SENSOR	EXCEEDED UPPER LIMIT	Problematic cold cranking. Possible power reduction.	Faulty sensor, interrupted wiring.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	
14	02	ENGINE 1 - COOLANT TEMPERATURE SENSOR	BELOW LOWER LIMIT	Problematic cold cranking. Possible power reduction.	Faulty sensor, interrupted wiring.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
14	08	ENGINE 1 - COOLANT TEMPERATURE SENSOR	SIGNAL NOT PLAUSIBLE	Problematic cold cranking. Possible power reduction.	Faulty sensor, interrupted wiring.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	
15	01	ENGINE 1 - COOLANT TEMPERATURE SENSOR (TEST)	EXCEEDED UPPER LIMIT		Faulty coolant temperature sensor.	Replace sensor.	1- Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A58 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A41 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Min. value: 0,11 KOhm; Max. value: 48,3 KOhm; Typical Value: 2,5 KOhm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
1E	08	VEHICLE - CLUTCH SIGNAL SUSPECT	SIGNAL NOT PLAUSIBLE	Clutch switch: signal either not plausible or not present. Cruise Control / PTO not working or engine revs up to maximum speed when clutch pedal is pressed and Cruise control / PTO is on.	Gear shift detected without pressing brake pedal.	Check wiring and connections. Replace sensor if required.				The anomaly caused by incomplete clutch operation if everything is OK.
20	01	EGR - EGR POWER ST. SHORT TO BATT. (if present)	EXCEEDED UPPER LIMIT		EGR solenoid valve short-circuit to battery.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.
21	02	EGR - SHORT CIRCUIT TO GROUND ON EGR VALVE (if present)	BELOW LOWER LIMIT		Solenoid valve short-circuit to ground.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.
22	04	EGR - OPEN CIRCUIT ON EGR VALVE (if present)	NO SIGNAL		EGR solenoid valve short-circuit or open circuit.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
22	08	EGR - OPEN CIRCUIT ON EGR VALVE (if present)	SIGNAL NOT PLAUSIBLE		EGR solenoid valve short-circuit or open circuit.	1) Check integrity of solenoid valve with multimeter. 2) Check wiring between solenoid valve and EDC connector.				EGR either not working or always working. Emissions not compliant with law. No reaction perceivable by driver.
24	01	ENGINE SPEED - CAMSHAFT SENSOR	EXCEEDED UPPER LIMIT	Possible problematic cold cranking.	No signal, open circuit.	Check wiring and connections.				Flywheel sensor timing signal adopted if camshaft signal is not correct.
24	02	ENGINE SPEED - CAMSHAFT SENSOR	BELOW LOWER LIMIT	Possible problematic cold cranking.	No signal, open circuit, faulty sensor.	Check correct assembly of sensor and phonic wheel, check engine timing.				Flywheel sensor timing signal adopted if camshaft signal is not correct.
25	01	ENGINE SPEED - CRANKSHAFT SENSOR	EXCEEDED UPPER LIMIT	Problematic cold cranking, power reduction (possible noise due to missed pre-injection).	Faulty sensor.	Check wiring and connections.				Camshaft sensor speed adopted if signal is not present.
25	02	ENGINE SPEED - CRANKSHAFT SENSOR	BELOW LOWER LIMIT	Problematic cold cranking, power reduction (possible noise due to missed pre-injection).	Faulty sensor.	Check wiring and connections.				Camshaft sensor speed adopted if signal is not present.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
26	01	ENGINE SPEED - FAULT BETWEEN FLYWHEEL SENSOR AND CAMSHAFT	EXCEEDED UPPER LIMIT	Possible power reduction.	Incorrect camshaft phonic wheel assembly.	Check wiring, connections and sensor, check that phonic wheel is fitted correctly.				Longer cranking time.
28	01	ENGINE 1 - FUEL TEMPERATURE SENSOR	EXCEEDED UPPER LIMIT	Possible power reduction.	Short-circuit to positive, excessively low temperature is detected.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (Ohm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A52 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A51 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
28	02	ENGINE 1 - FUEL TEMPERATURE SENSOR	BELOW LOWER LIMIT	Possible power reduction.	Short-circuit to ground, excessively high temperature is detected.	Check wiring and connections. Replace sensor if required.	1- Measure type: Resistance (Ohm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A52 Measure point 2: Sensor Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A51 Measure point 2: Sensor Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Typical Value: 0,1 Ohm;	
29	01	ENGINE 1 - FAN RELAY	EXCEEDED UPPER LIMIT	Fan relay not working.	Fan relay short-circuit to positive.	Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
29	02	ENGINE 1 - FAN RELAY	BELOW LOWER LIMIT	Fan relay not working.	Fan relay short-circuit to ground.	Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
29	04	ENGINE 1 - FAN RELAY	NO SIGNAL	Fan relay not working.		Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
29	08	ENGINE 1 - FAN RELAY	SIGNAL NOT PLAUSIBLE	Fan relay not working.		Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
2A	01	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	EXCEEDED UPPER LIMIT	Fuel filter pre-heater relay not working.	Filter heater relay short-circuit to positive - Heater always on also at fuel temperature > 5° C.	Check wiring and connections. Replace relay if required.				Battery goes flat.
2A	02	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	BELOW LOWER LIMIT	Fuel filter pre-heater relay not working.	Filter heater relay short-circuit to ground.	Check wiring and connections. Replace relay if required.				Battery goes flat.
2A	04	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	NO SIGNAL	Fuel filter pre-heater relay not working.		Check wiring and connections. Replace relay if required.				Battery goes flat.
2A	08	ENGINE 1 - PRE-HEATING RELAY FUEL FILTER	SIGNAL NOT PLAUSIBLE	Fuel filter pre-heater relay not working.		Check wiring and connections. Replace relay if required.				Battery goes flat.
2F	01	ENGINE 2 - GLOW PLUGS RELAY	EXCEEDED UPPER LIMIT	Possible problematic cold cranking.	Short-circuit to positive, glow plugs always on also with ECU off, possible battery deployment.	Check wiring and connections. Replace relay if required.				
2F	02	ENGINE 2 - GLOW PLUGS RELAY	BELOW LOWER LIMIT		Short-circuit to ground, glow plugs always on.	Check wiring and connections. Replace relay if required.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
2F	04	ENGINE 2 - GLOW PLUGS RELAY	NO SIGNAL	Possible problematic cold cranking.	Faulty wiring.	Check wiring and connections. Replace relay if required.				Faulty diagnostic light.
2F	08	ENGINE 2 - GLOW PLUGS RELAY	SIGNAL NOT PLAUSIBLE	Possible problematic cold cranking.	Faulty relay, wiring interrupted.	Check wiring and connections. Replace relay if required.				Possible increased fuel consumption. Possible engine overheating and power reduction.
30	01	ENGINE 2 - GLOW PLUG W/LIGHT	EXCEEDED UPPER LIMIT	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.	Short-circuit to positive.	Check wiring and connections. Replace sensor if required.				The driver does not wait preheating even when the room temperatures are low, because no warning light signal is enabled. Preheating works, but with cold start-up no indication is available that tells you when to start the motor because the light is always turned on.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
30	02	ENGINE 2 - GLOW PLUG W/LIGHT	BELOW LOWER LIMIT	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.	Short-circuit to ground.	Check wiring and connections. Replace sensor if required.				The driver does not wait preheating even when the room temperatures are low, because no warning light signal is enabled. Preheating works, but with cold start-up no indication is available that tells you when to start the motor because the light is always turned on.
30	04	ENGINE 2 - GLOW PLUG W/LIGHT	NO SIGNAL	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.		Check wiring and connections. Replace sensor if required.				Warning light off during pre-heating. Replace bulb if required.
30	08	ENGINE 2 - GLOW PLUG W/LIGHT	SIGNAL NOT PLAUSIBLE	Warning light always off. Problematic cold cranking. Pre-heater warning light always on.		Check wiring and connections. Replace sensor if required.				Warning light off during pre-heating. Replace bulb if required.
31	01	ENGINE 2 - GLOW PLUGS	EXCEEDED UPPER LIMIT	Possible problematic cold cranking.	Short-circuit to positive.	Check wiring and connections. Check electrical system between relay and glow plugs.				Relay unit always on also with ECU off, possible battery deployment.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
32	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
33	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
33	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
33	04	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	NO SIGNAL	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
33	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE	The engine switching off-data are not memorized. The failures memory is lost, only the present failures and not the intermittent ones can be read, the idling speed, which can be eventually set by the Cruise Control commands, remains not memorized. (If present)	Faulty ECU EEPROM.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
34	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
35	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
36	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
37	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
38	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
39	01	ENGINE 1 - AIR TEMPERATURE SENSOR	EXCEEDED UPPER LIMIT	Problematic cranking, smoke, problematic acceleration.		Check wiring and connections. Replace sensor if required.	Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2	Connector Not connected; Key +15 OFF;	Typical Value: 2,5 KOhm;	Air temperature sensor and built-in pressure sensor. The sensor is fitted on flow meter in engines with EGR.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
39	02	ENGINE 1 - AIR TEMPERATURE SENSOR	BELOW LOWER LIMIT	Problematic cranking, smoke, problematic acceleration.	Short-circuit to ground, excessively high temperature is detected.	Check wiring and connections. Replace sensor if required.	Measure type: Resistance (KOhm) Measure point 1: Sensor Pin: 1 Measure point 2: Sensor Pin: 2	Connector Not connected; Key +15 OFF;	Typical Value: 2,5 KOhm;	Air temperature sensor and built-in pressure sensor. The sensor is fitted on flow meter in engines with EGR.
3A	02	ELECTRONIC CONTROL UNIT - IMMOBILISER (if present)	BELOW LOWER LIMIT	The engine fails to start	Communication with Immobilizer ECU problems on CAN Line.	Check integrity of CAN Line, run Immobilizer ECU diagnostics and wait for indications provided.	Measure type: Resistance (Ohm) Measure point 1: Diagnostic socket. Pin: 21 Measure point 2: Diagnostic socket. Pin: 22	Connector Connected; Key +15 OFF;	Typical Value: 60 Ohm Ohm;	
3C	01	INJECTOR - BENCH 1	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3C	02	INJECTOR - BENCH 1	BELOW LOWER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to ground.	Check wiring and connections.				Only two cylinders running.
3C	08	INJECTOR - BENCH 1	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector electrical system failure.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3D	04	INJECTOR - BENCH 1	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring disconnected.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3E	01	INJECTOR - BENCH 2	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
3E	02	INJECTOR - BENCH 2	BELOW LOWER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to ground.	Check wiring and connections.				Only two cylinders running.
3E	08	INJECTOR - BENCH 2	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector electrical system failure.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
3F	04	INJECTOR - BENCH 2	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring disconnected.	Check wiring and connections. Replace injector if required.				Only two cylinders running.
40	01	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	EXCEEDED UPPER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
40	02	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	BELOW LOWER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
40	04	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	NO SIGNAL	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
40	08	STAGE A INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	SIGNAL NOT PLAUSIBLE	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
41	01	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	EXCEEDED UPPER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
41	02	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	BELOW LOWER LIMIT	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
41	04	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	NO SIGNAL	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
41	08	STAGE B INJECTORS CONTROL, CENTRAL UNIT INTERNAL PORTION	SIGNAL NOT PLAUSIBLE	Engine off.	Internal ECU problem.	Clear failure memory. If the error persists, ensure that the failure does not concern the injectors and call the Help Desk for instructions on how to replace the ECU.				
42	01	INJECTOR - INJECTOR 1	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.				Only three cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
42	01	INJECTOR - INJECTOR 1	EXCEEDED UPPER LIMIT				1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A47 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A16 Measure point 2: Injector Pin: 1	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0.1 Ohm; 2- Min. value: 0.5 Ohm; Max. value: 0.9 Ohm; Typical Value: 0.7 Ohm; 3- Typical Value: 0,1 Ohm;	
42	04	INJECTOR - INJECTOR 1	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A47 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A16 Measure point 2: Injector Pin: 1	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0.1 Ohm; 2- Min. value: 0.5 Ohm; Max. value: 0.9 Ohm; Typical Value: 0.7 Ohm; 3- Typical Value: 0,1 Ohm;	Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
42	08	INJECTOR - INJECTOR 1	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A47 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A16 Measure point 2: Injector Pin: 1	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0.1 Ohm; 2- Min. value: 0.5 Ohm; Max. value: 0.9 Ohm; Typical Value: 0.7 Ohm; 3- Typical Value: 0,1 Ohm;	Only three cylinders running.
43	04	INJECTOR - INJECTOR 1	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.				Only three cylinders running.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
44	01	INJECTOR - INJECTOR 2	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A17 Measure point 2: Injector Pin: 1 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A13 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: O,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
44	04	INJECTOR - INJECTOR 2	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A17 Measure point 2: Injector Pin: 1 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A13 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: O,9 Ohm; Typical Value: 0,7 Ohm;	Only two cylinders running.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
44	08	INJECTOR - INJECTOR 2	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A17 Measure point 2: Injector Pin: 1 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A13 Measure point 2: Injector Pin: 2 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: O,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
45	04	INJECTOR - INJECTOR 2	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
46	01	INJECTOR - INJECTOR 3	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
46	04	INJECTOR - INJECTOR 3	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
46	08	INJECTOR - INJECTOR 3	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
47	04	INJECTOR - INJECTOR 3	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A31 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A1 Measure point 2: Injector Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: 0,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
48	01	INJECTOR - INJECTOR 4	EXCEEDED UPPER LIMIT	Engine not working properly, possible power reduction.	Short-circuit to positive.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
48	04	INJECTOR - INJECTOR 4	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring short-circuit.	Check wiring and connections. Replace injector if required.				Only two cylinders running.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
48	08	INJECTOR - INJECTOR 4	SIGNAL NOT PLAUSIBLE	Engine not working properly, possible power reduction.	Injector not working properly.	Check wiring and connections. Replace injector if required.				Only three cylinders running.
49	04	INJECTOR - INJECTOR 4	NO SIGNAL	Engine not working properly, possible power reduction.	Injector wiring open circuit.	Check wiring and connections. Replace injector if required.	1- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A46 Measure point 2: Injector Pin: 2 2- Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A1 Measure point 2: Injector Pin: 1 3- Measure type: Resistance (Ohm) Measure point 1: Injector Pin: 1 Measure point 2: Injector Pin: 2	1- Connector Not connected; Key +15 OFF; 2- Connector Not connected; Key +15 OFF; 3- Connector Not connected; Key +15 OFF;	1- Typical Value: 0,1 Ohm; 2- Typical Value: 0,1 Ohm; 3- Min. value: 0,5 Ohm; Max. value: 0,9 Ohm; Typical Value: 0,7 Ohm;	Only three cylinders running.
4E	08	VEHICLE - CRUISE CONTROL SWITCH UNIT (if present)	SIGNAL NOT PLAUSIBLE	Cruise control / PTO not working.	Press SET+ / SET- and RESUME/ OFF at the same time.	Check correct operation of the switch by reading state parameters.				Replace wiring and connections if state does not change when Cruise Control buttons are pressed.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
50	01	ELECTRONIC CONTROL UNIT - MAIN RELAY DEFECT	EXCEEDED UPPER LIMIT	Engine does not start, ECU not powered or ECU always powered and EDC off also at key-on.	Main relay interrupted or short-circuit.	Check wiring and connections. Replace relay if required.				
50	02	ELECTRONIC CONTROL UNIT - MAIN RELAY DEFECT	BELOW LOWER LIMIT	Engine does not start, ECU not powered or ECU always powered and EDC off also at key-on.	Main relay interrupted or short-circuit.	Check wiring and connections. Replace relay if required.				
51	01	VEHICLE - MULTIPOSITION SELECTOR / PTO (if present)	EXCEEDED UPPER LIMIT	Incorrect PTO operation.	Voltage exceeding max. threshold, short-circuit to positive.	Check wiring and connections. Replace sensor if required.				
51	02	VEHICLE - MULTIPOSITION SELECTOR / PTO (if present)	BELOW LOWER LIMIT	Incorrect PTO operation.	Voltage under min. threshold, short-circuit to ground.	Check wiring and connections. Replace sensor if required.				
51	08	VEHICLE - MULTIPOSITION SELECTOR / PTO (if present)	SIGNAL NOT PLAUSIBLE	Incorrect PTO operation.	Faulty device.	Check wiring and connections. Replace sensor if required.				
52	04	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR	NO SIGNAL	Engine off.	Faulty MPROP.	Check wiring and connections.	Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A49 Measure point 2: ECU Pin: A19	Connector Not connected; Key +15 OFF;	Min. value: 3.2 Ohm; Max. value: 3.6 Ohm; Typical Value: 3.4 Ohm;	High noise.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
52	08	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR	SIGNAL NOT PLAUSIBLE			Check wiring and connections. Replace ECU if required.	Measure type: Resistance (Ohm) Measure point 1: ECU Pin: A49 Measure point 2: ECU Pin: A19	Connector Not connected; Key +15 OFF;	Min. value: 3.2 Ohm; Max. value: 3.6 Ohm; Typical Value: 3.4 Ohm;	
53	01	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR (SHORT CIRCUIT TO POSITIVE)	EXCEEDED UPPER LIMIT		Short-circuit to battery, faulty MPROP.	Check wiring and connections. Replace MPROP if required.				
54	01	FUEL PRESSURE - PRESSURE MPROP REGULATOR ERROR (SHORT CIRCUIT TO NEGATIVE)	EXCEEDED UPPER LIMIT		Short-circuit to ground. Faulty MPROP.	Check wiring and connections. Replace MPROP if required.				
56	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
5A	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
5A	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
5B	01	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	EXCEEDED UPPER LIMIT		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
5E	01	ENGINE 1 - FUEL PUMP RELAY	EXCEEDED UPPER LIMIT	Fuel pump on always when engine is off.	Faulty relay, short-circuit to positive in wiring.	Turn key-on: pump must run for approximately 10 seconds (it should hum). Check pump relay if pump remains on. Check wiring if all checks are OK.				

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
5E	02	ENGINE 1 - FUEL PUMP RELAY	BELOW LOWER LIMIT	Fuel pump not working.	Faulty relay, short-circuit to ground in wiring.	Turn key-on: pump must run for approximately 10 seconds (it should hum). Check the pump relay, protection fuse and wiring if this does not occur.				
5E	04	ENGINE 1 - FUEL PUMP RELAY	NO SIGNAL	Fuel pump not working.	Faulty relay, wiring interrupted.	Check wiring and connections. Replace relay if required.				
5E	08	ENGINE 1 - FUEL PUMP RELAY	SIGNAL NOT PLAUSIBLE	Fuel pump not working.	Faulty relay, wiring interrupted.	Check wiring and connections. Replace relay if required.				
5F	01	FUEL PRESSURE - RAIL PRESSURE SENSOR OR SIGNAL ERROR	EXCEEDED UPPER LIMIT		Short-circuit to positive. Faulty sensor. Rail pressure not regular.	Check wiring and connections. Replace sensor if required.				Check DTC 103 error.
5F	02	FUEL PRESSURE - RAIL PRESSURE SENSOR OR SIGNAL ERROR	BELOW LOWER LIMIT		Short-circuit to ground, faulty sensor.	Check wiring and connections. Replace sensor if required.				
60	01	FUEL PRESSURE - RAIL PRESSURE SENSOR OFFSET	EXCEEDED UPPER LIMIT		Faulty rail pressure sensor.	Replace sensor.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
60	02	FUEL PRESSURE - RAIL PRESSURE SENSOR OFFSET	BELOW LOWER LIMIT		Faulty rail pressure sensor.	Replace sensor.				
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		High pressure circuit fuel leakage.	Check fuel feed system.				Fuel management and pressure failure in rail.
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		Injector jammed in fuel passage open position.	Check hydraulic and mechanical efficiency of injectors.				Fuel management and pressure failure in rail.
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		MPROP adjuster open movement jammed.	Check efficiency of MPROP adjuster.				Fuel management and pressure failure in rail.
62	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (POSITIVE DEVIATION)	EXCEEDED UPPER LIMIT		Faulty high pressure pump.	Check efficiency of high pressure pump.				Fuel management and pressure failure in rail.

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
63	01	FUEL PRESSURE - FAULT ON THE FUEL DRUCK CONTROL OF THE RAIL (NEGATIVE DEVIATION)	EXCEEDED UPPER LIMIT		MPROP adjuster open movement jammed.	Check efficiency of MPROP adjuster.				Fuel management and pressure failure in rail.
64	01	FUEL PRESSURE - RAIL PRESSURE ERROR: TOO LOW	EXCEEDED UPPER LIMIT		High pressure circuit fuel leakage.	Check high pressure system. Replace high pressure pump if required.				Fuel management and pressure failure in rail.
65	01	FUEL PRESSURE - RAIL PRESSURE ERROR: TOO HIGH	EXCEEDED UPPER LIMIT		MPROP regulator jammed.	Check MPROP regulator, replace if required.				
66	01	FUEL PRESSURE - ERROR ON THE RAIL PRESSURE (EXCESSIVE DUTY CYCLE)	EXCEEDED UPPER LIMIT	Negative vehicle reaction with smoke in exhaust during acceleration.	High pressure circuit fuel leakage.	Check fuel feed system, replace high pressure pump if required. Faulty fuel feed system (fuel pump and filter jammed).				
67	01	FUEL PRESSURE - ERROR ON THE RAIL PRESSURE (EXCESSIVE)	EXCEEDED UPPER LIMIT	Engine off.	MPROP regulator jammed.	Check MPROP regulator, replace if required.				Replace pressure relief valve.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
68	02	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	BELOW LOWER LIMIT			Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
68	04	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	NO SIGNAL		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				
68	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
69	01	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	EXCEEDED UPPER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
69	02	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	BELOW LOWER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6A	01	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	EXCEEDED UPPER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
6A	02	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	BELOW LOWER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6B	01	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	EXCEEDED UPPER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6B	02	ELECTRONIC CONTROL UNIT - SENSOR POWER SUPPLY	BELOW LOWER LIMIT	Anomalous engine operation due to incorrectly powered sensors. Reduced power.	Sensor power circuit fault in ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				Possible fault indications of various sensors powered by ECU.
6C	01	VEHICLE - EDC LAMP	EXCEEDED UPPER LIMIT	Warning light not working.	Short-circuit to positive.	Check correct operation of warning light using "Active diagnostic" procedure.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.

DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
6C	02	VEHICLE - EDC LAMP	BELOW LOWER LIMIT	Warning light not working.	Short-circuit to ground.	Check correct operation of warning light using "Active diagnostic" procedure.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.
6C	04	VEHICLE - EDC LAMP	NO SIGNAL	Warning light not working.	Open circuit, bulb disconnected.	Check correct operation of warning light using "Active diagnostic" procedure.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.
6C	08	VEHICLE - EDC LAMP	SIGNAL NOT PLAUSIBLE	Warning light not working.	Wiring problems.	Check wiring and connections. Replace sensor if required.				Warning light should come on for approximately 5 seconds at key-on. Check wiring and connections if this does not occur.
6D	08	ENGINE 2 - INTERNAL ECU FAULT (PLAUSIBILTY ERROR +15)	SIGNAL NOT PLAUSIBLE			Check wiring and connections.				Key 15 off during initialisation.
6E	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
75	01	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	EXCEEDED UPPER LIMIT	Speed of 170 km/h exceeded.		Check correct calibration of speedometer.				Encourage driver to use the vehicle correctly.
75	04	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	NO SIGNAL		Interrupted wiring between vehicle speed sensor and instrument panel.	Check wiring and connections between vehicle speed sensor and instrument panel.				Intervention required if instrument panel indicates vehicle speed.
75	04	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	NO SIGNAL		Wiring interrupted between instrument panel and EDC ECU.	Check wiring and connections between instrument panel and EDC ECU.				
75	04	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	NO SIGNAL		Vehicle speed sensor disconnected or failed.	Check correct assembly and efficiency of vehicle speed sensor.				
75	08	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	SIGNAL NOT PLAUSIBLE		Vehicle speed sensor disconnected or failed.	Check correct assembly and efficiency of vehicle speed sensor.				
75	08	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	SIGNAL NOT PLAUSIBLE	Vehicle speed on instrument panel does not increase sensibly.	Wrong speedometer setting.	Check correct calibration of speedometer.				
77	01	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	EXCEEDED UPPER LIMIT	Wrong vehicle speed indication.	Wrong speedometer setting.	Check correct calibration of speedometer.				
77	02	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	BELOW LOWER LIMIT	Wrong vehicle speed indication.	Wrong speedometer setting.	Check correct calibration of speedometer.				

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DTC	FMI	Failing component	Type of Failure	Visible failure	Possible Cause	Repair action	Checks to be performed	Measuring conditions	Values to be detected	Remarks
77	08	VEHICLE - VEHICLE SPEED SENSOR / SIGNAL	SIGNAL NOT PLAUSIBLE	Wrong vehicle speed indication.	Wrong speedometer setting.	Check correct calibration of speedometer.				
79	08	ELECTRONIC CONTROL UNIT - INTERNAL ECU FAULT	SIGNAL NOT PLAUSIBLE		Wrong ECU programming. Probable electromagnetic interference. Faulty ECU.	Switch key on/off and wait for a few seconds, clear failure memory. If the error persists, call the Help Desk for instructions on how to replace the ECU.				

SYMPTOMS

The second section describes possible trouble that **is not identifiable by the control unit and is**

SPECIFIC TO THE COMMON RAIL SYSTEM AND THE NEW HW ENGINE

HYDRAULIC

ELECTRIC

MECHANICAL

other than conventional defects

(the aim is to guide the diagnostic approach to a new system, not to restate basic concepts that are considered to have already been acquired by the repairer).

The possible trouble already identified by the control unit, described in the 1st Section, is not repeated here (e.g., the engine cuts out as a result of defect 8.1).

If there are errors stored in the control unit memory, refer to the 1st troubleshooting section.

- ❑ The engine cuts out or fails to start.
- ❑ The engine fails to start (considerable exhaust smoke).
- ❑ The engine starts with difficulty.
- ❑ The engine fails to reach its top performance.

SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine cuts out or fails to start.	The EDC indicator light fails to come on. The starter motor turns but the engine fails to start.	EDC control unit not powered: fuse blown.	Check central unit EDC protection fuse. If the fuse has blown, find and eliminate the cause of the overload before replacing it.	
The engine cuts out or fails to start.	The EDC indicator light fails to come on. The starter motor turns but the engine fails to start.	EDC control unit not powered: the main relay is not powered.	Check the wiring upstream from the main relay to find any break in the circuit.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Air intake in the supply circuit between the tank and motor pump.	Check the integrity of the pipe and check that the quick couplings on the CILC (fuel level indicator assembly) and on the motor pump inlet are fitted properly. Replace any non-conforming parts.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Pre-filter clogged.	Inspect and replace the pre-filter if any debris is found inside.	The pre-filter is transparent and any debris is easy to see.
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Low-pressure pipe between motor pump and high-pressure pump inlet choked or with large leak.	Inspect the pipe and replace the relevant section.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Fuel filter greatly clogged (within certain limits it only involves difficult starting).	Replace the filter.	If the filter clogging indicator system has not worked, check the relevant electric circuit and restore its operation.

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SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Rail pressure relief valve jammed open or lost its setting (continually discharges towards the tank).	If fuel has come out of the valve exhaust pipe while driving with the starter motor, change the valve.	
The engine cuts out or fails to start.	The EDC control unit is powered, the starter motor turns but the engine fails to start. The rail pressure does NOT reach 200 bar.	Mechanical defect in the gear pump, pressure regulator and the pumping elements of the high-pressure pump.	After checking there is fuel in the tank and excluding every other possibility (see 1st Troubleshooting Section), replace the high-pressure pump together with the pressure regulator.	
The engine cuts out or fails to start.	The starter motor turns but the engine fails to start. The rail pressure during starting regularly rises above 200 bar.	EGR pneumatic valve jammed open and air throttle valve jammed shut. (If present)	Check and replace the defective components.	
The engine starts with difficulty.	The EDC control unit is powered, the starter motor turns but the engine starts only after insisting a long time. Very slow increase in rail pressure.	The fuel motor pump is not powered (no buzzing is heard with the key ON for 9 sec.).	Check that no electric cable has disconnected from the motor pump. Check the wiring between the control relay and the motor pump to identify any break in the circuit.	After starting, with a load request the engine goes into recovery (if due to insufficient fuel reaching the high-pressure pump error 8.1 is detected, see 1st Section).
The engine starts with difficulty.	The rail pressure during starting regularly rises above 200 bar.	Injector mechanically jammed shut.	Perform the Engine Test (cylinder efficiency) to identify the defective injector and replace it.	Depending on the extent of the jamming, the control unit might detect a lack of balance between the cylinders (See error 3.1 – 3.2 – 3.3 – 3.4, 1st Section).
The engine starts with difficulty.	The rail pressure during starting regularly rises above 200 bar.	EGR pneumatic valve jammed open or air throttle valve mechanically jammed shut. (If present)	Check which component is defective and replace it.	

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SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine starts with difficulty.	The rail pressure during starting does not reach 200 bar immediately.	Air intake in the supply circuit between the tank and motor pump.	Check the integrity of the pipe and check that the quick couplings on the CILC (fuel level indicator assembly) and on the motor pump inlet are fitted properly. Replace any non-conforming parts.	
The engine starts with difficulty.	The rail pressure during starting does not reach 200 bar immediately.	The motor pump is not powered (no buzzing is heard with the key ON for 9 sec.).	Check the wiring between the control relay and the motor pump.	
The engine starts with difficulty.	The rail pressure during cranking does not reach 200 bar immediately.	Low-pressure pipe choked or broken or leaking.	Inspect the pipe and replace the relevant section.	
The engine starts with difficulty.	The rail pressure during cranking does not reach 200 bar immediately.	Fuel filter very clogged.	Replace the filter. If the filter clogging indicator system has not worked, check the relevant circuit and restore its operation.	
The engine fails to reach top performance	(with no derating implemented by the control unit)	Throttle pedal potentiometer does not go to the end of its travel.	Read parameters, check the signal reaches 100%. If it does not, check the physical integrity of the potentiometer and replace it if necessary.	If there are errors saved in the control unit memory, refer to the 1st Troubleshooting Section.
The engine fails to reach top performance	(with no derating implemented by the control unit)	EGR pneumatic valve jammed open or throttle valve jammed shut. (If present)	Check which is the defective component and replace it.	
The engine fails to reach top performance	(with no derating implemented by the control unit)	Injector jammed shut.	Find the defective injector (cylinder efficiency test with the diagnostic instrument) and replace it.	

SYMPTOM	SYSTEM REACTION	POSSIBLE CAUSE	TESTS OR RECOMMENDED ACTION	NOTES
The engine fails to reach top performance	(with no derating implemented by the control unit)	Fuel filter greatly clogged.	Change the filter. If the filter clogging indicator system has not worked, check the relevant circuit and restore its operation.	
The engine fails to reach top performance	(with no derating implemented by the control unit)	The motor pump is not powered (no buzzing is heard with the key ON for 9 sec.).	Check the wiring between the control relay and the motor pump.	

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PART FOUR - MAINTENANCE PLANNING

Maintenance

MAINTENANCE

The covered distances indicated in this schedule are typical of engines used in vehicles.

Recovery

To ensure optimised working conditions, in the following pages we are providing instructions for the overhaul control interventions, checks and setting operations that must be performed on the engine at due planned dates.

The frequency of the maintenance operations is just an indication since the use of the engine is the main characteristic to determine and evaluate replacements and checks.

It is not only allowed but recommended that the staff in charge of the maintenance should also carry out the necessary maintenance and controlling operations even if not being included in the ones listed here below but that may be suggested by common sense and by the specific conditions in which the engine is run.

Checks not included in maintenance planning-daily checks

It is a good habit to execute, before engine start, a series of simple checks that might represent a valid warranty to avoid inconveniences, even serious, during engine running. Such checks are usually up to the operators and to the vehicle's drivers.

- Level controls and checks of any eventual leakage from the fuel, cooling and lubricating circuits.

- Notify the maintenance if any inconvenience is detected of if any filling is necessary.

After engine start and while engine is running, proceed with the following checks and controls:

- check presence of any eventual leakage from the fuel, cooling and lubricating circuits.

- Verify absence of noise or unusual rattle during engine working.

- Verify, using the vehicle devices, the prescribed pressure temperature and other parameters.

- Visual check of fumes (colour of exhaust emissions)

- Visual check of cooling liquid level, in the expansion tank.

Inspection and/or maintenance interventions

	Type of intervention	Regular intervals
LUBRICATION, CHANGING OIL, FILTERS AND CHECKING FLUIDS		
1	Changing engine oil	40.000
1	Changing engine oil filter	40.000
2	Changing fuel filter *	40.000
3	Visually checking fuel pre-filter clogging (if present)	40.000
CHECKS IN THE ENGINE BAY		
•	Checking state of auxiliary drive belts	40.000
•	Changing auxiliary drive belts (1)	120.000
DIAGNOSTICS		
•	Engine EDC system check-up via diagnosis tool	120.000

(1) *Replace every four years. Replace every 60.000 km under harsh conditions of use (dust and/or heat).*

(*) *If the "clogged filter" warning lamp lights up on the instrument panel, the filter must be replaced before the programmed replacement interval*

The frequency of the maintenance operations is just an indication since the use of the F1C engine is the main characteristic to determine and evaluate replacements and checks.
The maintenance operations are valid only if the setter fully complies with all the installation prescriptions provided by Iveco Motors.

Extra plan operations (to be carried out possibly in combination with maintenance service)

EVERY 240,000 km or, anyhow, every 5 years (or 4,800 hours)

- ❑ Changing the timing system driving belt (1).
- ❑ Changing the automatic tensioner of the timing system driving belt.
- ❑ Changing the automatic tensioner of the belt driving the alternator and hydraulic pump
- ❑ Changing the pre-heating glow plugs.

EACH YEAR - especially in early springtime

- ❑ In the case of low mileage, change the filters once a year, early each spring.

EACH YEAR - before the winter season

- ❑ Check coolant density.

EVERY THREE YEARS - even if there is no indication of the air filter clogging

- ❑ Change cartridge and clean air filter container (2).
- ❑ Change engine coolant.

(1) *The timing belt must be replaced in any case every 5 years.*

(2) *Early air cleaner obstruction is generally due to particular environmental conditions. For this reason it may need to be replaced when indicated by the sensor regardless of the replacement interval also if not specifically stated.*

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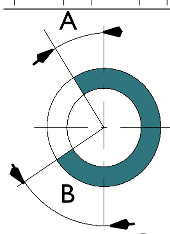
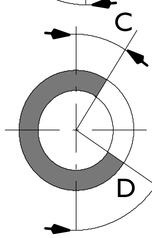
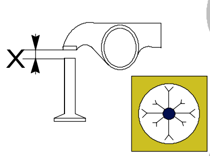
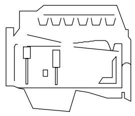
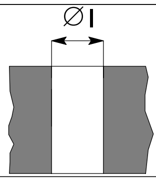
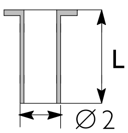
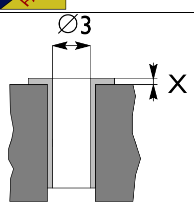
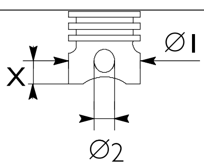
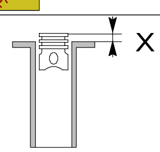
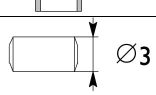
SECTION 4

Features and general overhaul

GENERAL SPECIFICATIONS

	Type		**F1CE0481A*....**	**F1CE0481B*....**
	Cycle		Diesel 4 strokes	
	Supply		Turbocharged with intercooler	
	Injection		Direct	
	Number of cylinders		4 in line	
	Bore	mm	95.8	
	Stroke	mm	104	
	Total displacement	cm^3	2998	
	TIMING SYSTEM			
	Start before T.D.C.	A	24°	
	end after B.D.C.	B	26°	
	Start before T.D.C.	D	70°	
	end after B.D.C.	C	24°	
	For timing check			
	X	mm	-	
		mm	-	
	Operation			
	X	mm	-	
		mm	-	
	FUEL FEED			
	Injection Type:	Bosch	high pressure common rail EDC16	
	Nozzle type		Injectors BOSCH	
	Injection sequence		1 - 3 - 4 - 2	
	Injection pressure	bar	1600	

ASSEMBLY DATA – CLEARANCES

	Type		F1CE0481A*....	F1CE0481B*....
CYLINDER ASSEMBLY AND CRANK MEMBERS				
	Cylinder liners:	Ø 1	95.802 ÷ 95.822	
	Cylinder liners: outside diameter length	 Ø L	- - -	
	Cylinder liners – crankcase seats (interference)		-	
IVECO PARTS >	Outside diameter	Ø 2	-	
	Cylinder liners: (protrusion from bottom of crankcase) inside diameter	 Ø 3	- -	
	Pistons: supplied as spares type measurement outside diameter seat for pin	 X Ø 1 Ø 2	MAHLE 58 95.591 ÷ 95.605 36.003 ÷ 36.009	
	Piston – cylinder liners		0.197 ÷ 0.231	
IVECO PARTS <	Piston diameter	Ø 1	0.4	
	Piston protrusion from crankcase	X	0.3 ÷ 0.6	
	Piston gudgeon pin	Ø 3	35.990 ÷ 35.996	
	Piston gudgeon pin – pin seat		0.07 ÷ 0.019	

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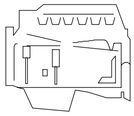
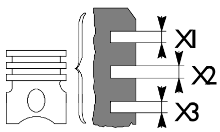
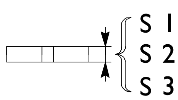
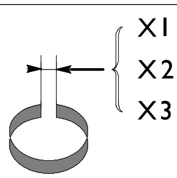
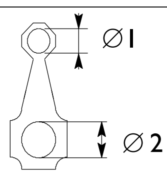
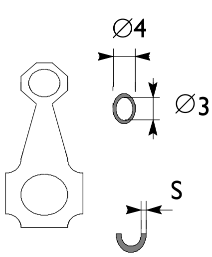
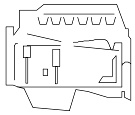
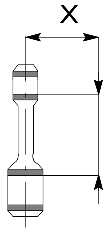
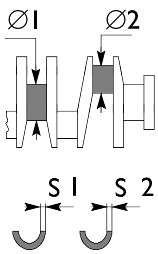
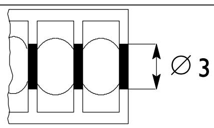
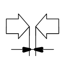
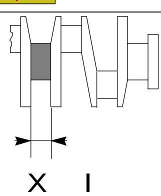
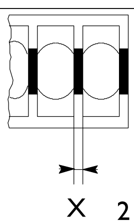
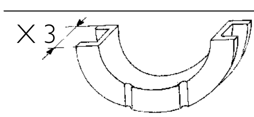
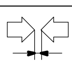
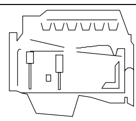
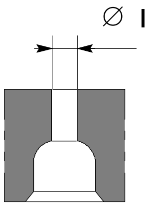
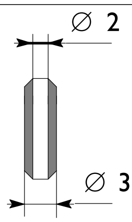
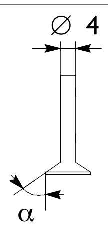
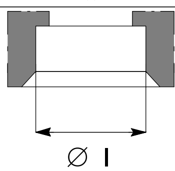
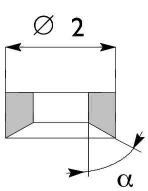
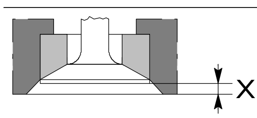
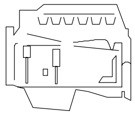
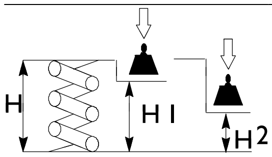
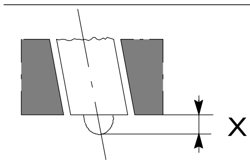
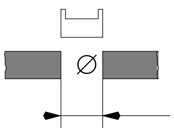
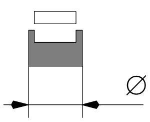
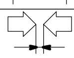
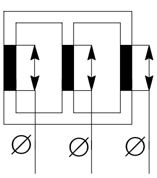
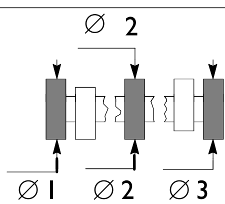
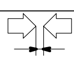
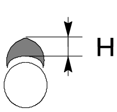
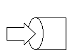
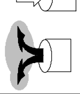
	Type	**F1CE0481A*....**	**F1CE0481B*....**
CYLINDER ASSEMBLY AND CRANK MEMBERS		mm	
	Type of piston X1* Piston ring slots X2 X3 * measured on Ø of 92.5 mm	- 2.197 2.200 ÷ 2.230 2.040 ÷ 2.060 2.050 ÷ 2.070 2.520 ÷ 2.540 2.540 ÷ 2.560	
	Piston rings: S1* S2 S3 * measured at 1.5 mm from the external Ø.	2.068 ÷ 2.097 1.970 ÷ 1.990 2.470 ÷ 2.490	
	Piston rings – slots 1 2 3	0.103 ÷ 0.162 0.060 ÷ 0.100 0.050 ÷ 0.090	
IVECO PARTS	Piston rings	0.4	
	Piston ring end opening in cylinder liner: X1 X2 X3	 0.20 ÷ 0.35 0.60 ÷ 0.80 0.25 ÷ 0.60	
	Small end bushing seat Ø 1 Connecting rod bearing seat* Ø 2 * connecting rod supplied as spare part	 39.460 ÷ 39.490 67.833 ÷ 67.848	
	Small end bushing diameter outside Ø 4 inside Ø 3 Big end bearing shells supplied as spare part S	 39.570 ÷ 39.595 36.010 ÷ 36.020 - 1,883 ÷ 1,892 1,885 ÷ 1,891	
	Small end bushing – seat (interference)	0.08 ÷ 0.135	
	Piston gudgeon pin – bushing	0.014 ÷ 0.030	
IVECO PARTS	Big end bearing shells	0.254 - 0.508	

	Type		F1CE0481A*....	F1CE0481B*....
CYLINDER ASSEMBLY AND CRANK MEMBERS			mm	
	Measurement	X	125	
	Maximum error on alignment of connecting rod axes	=	0.09	
	Main journals	Ø 1		
	No. 1-2-3-4		76.182 ÷ 76.208	
	No. 5		83.182 ÷ 83.208	
	Crankpins	Ø 2	64.015 ÷ 64.038	
	Main bearing shells	S1*	2.165 ÷ 2.174	
	Big end bearing shells	S2*	1.883 ÷ 1.892	
	* supplied as spare parts		1.885 ÷ 1.891	
	Main bearing housings	Ø 3		
	No. 1-2-3-4		80.588 ÷ 80.614	
	No. 5		87.588 ÷ 87.614	
	Bearing shells - main journals		0.032 ÷ 0.102	
	Bearing shells – crankpins		0.035 ÷ 0.083	
IVECO PARTS	Main bearing shells		0.254 ÷ 0.508	
	Big end bearing shells		0.254 ÷ 0.508	
	Main journal for shoulder	X 1	32.500 ÷ 32.550	
	Main bearing housing for shoulder	X 2	27.240 ÷ 27.290	
	Half thrust washers	X 3	32.310 ÷ 32.460	
	Crankshaft shoulder		0.040 ÷ 0.240	

	Type	F1CE0481A*....	F1CE0481B*....
			
CYLINDER HEAD – TIMING SYSTEM		mm	
	Guide valve seats on cylinder head ∅1	9.980 ÷ 10.000	
	Valve guides ∅2 / ∅3	6.023 ÷ 6.038 10.028 ÷ 10.039	
	Valve guides and seats on head (interference)	0.028 ÷ 0.059	
	Valve guides	0.05 - 0.10 - 0.25	
	Valves: ∅4 α ∅4 α	5.985 ÷ 6.000 60° ±7.5' 5.975 ÷ 5.990 60° ±7.5'	
	Valve stem and relevant guide	0.023 ÷ 0.053	
	Seat on head for valve seat: ∅1 ∅1	34.490 ÷ 34.415 34.490 ÷ 34.515	
	Outside diameter of valve seats; angle of valve seats on cylinder head: ∅2 α ∅2 α	34.590 ÷ 34.610 59.5° ±5' 34.590 ÷ 34.610 59.5° ±5'	
	Recessing X X	0.375 ÷ 0.525 0.375 ÷ 0.525	
	Between valve seat and head	0.075 - 0.12 0.075 - 0.12	
	Valve seats	-	

	Type	F1CE0481A*....	F1CE0481B*....
CYLINDER HEAD – TIMING SYSTEM		mm	
	Valve spring height: free spring H under a load of: N243 ± 12 H1 N533 ± 24 H2	54 45 35	
	Injector protrusion X	2.77 ÷ 3.23	
	Seats for tappets on cylinder head normal ∅	12.016 ÷ 12.034	
	Normal diameter tappets	11.988 ÷ 12.000	
	Between tappets and seats	0.016 ÷ 0.046	
	Camshaft pin seats in cylinder overhead 1 ⇒ 7 ∅ 1 ∅ 2 ∅ 3	 48.988 ÷ 49.012 46.988 ÷ 47.012 35.988 ÷ 36.012	
	Camshaft supporting pins: ∅ 1 ∅ 2 ∅ 3	 48.925 ÷ 48.950 46.925 ÷ 46.950 35.925 ÷ 35.950	
	Supporting pins and seats	0.032 ÷ 0.087	
	Useful cam height  H  H	 3.622 4.328	

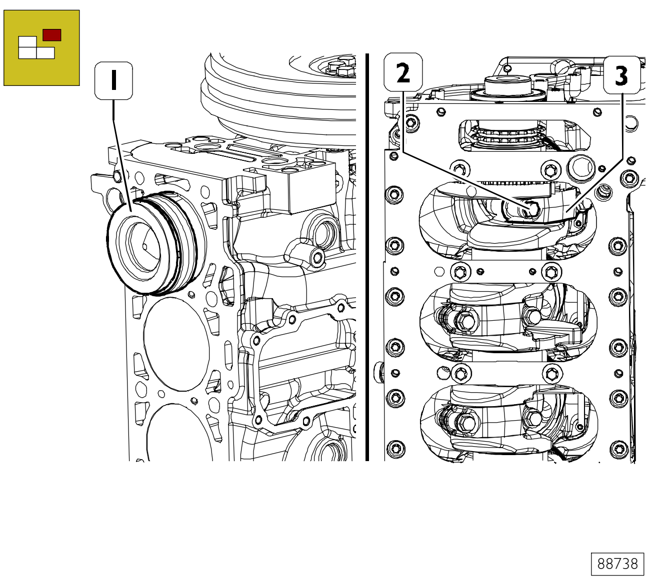
ENGINE OVERHAUL

The following instructions are prescribed on the understanding that the engine has previously been placed on the rotating bench and that removal of all specific components of the equipment have been already removed as well. (See Section 3 of the manual herein).

The section illustrates therefore all the most important engine overhaul procedures.

The following operations are relating to the 4 cylinders engine but are analogously applicable for the 6 cylinders.

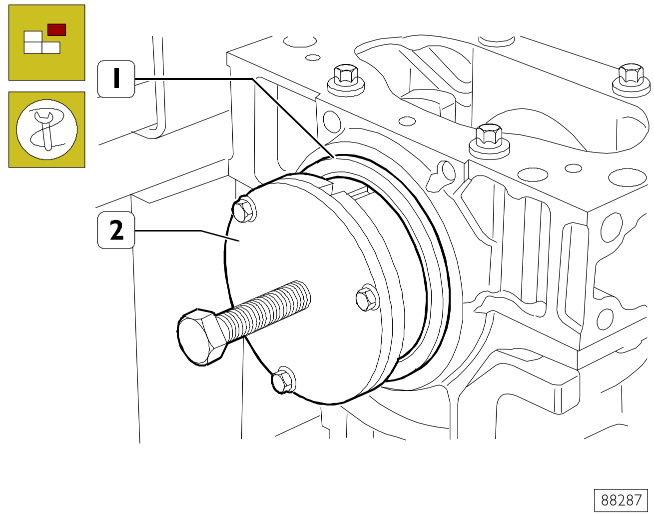
Figure 1



Take out the screws (2) and remove the connecting rod caps (3).
Extract the pistons (1) from the top of the crankcase.

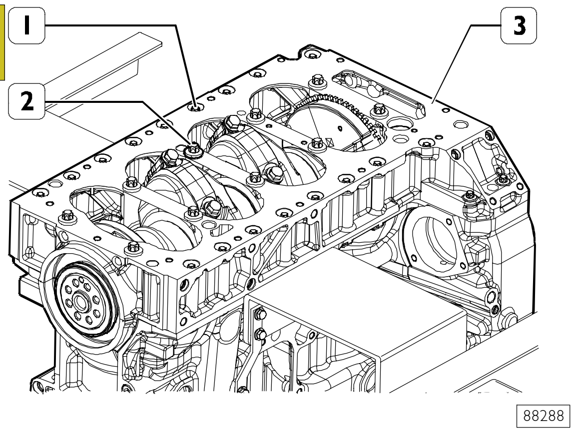
NOTE On the same side of the connecting rod and its associated cap, indicate the number of the cylinder from which the connecting rod has been removed. Keep the bearing shells in their respective housings since, if they are used, they will need to be fitted in the position found during removal.

Figure 2



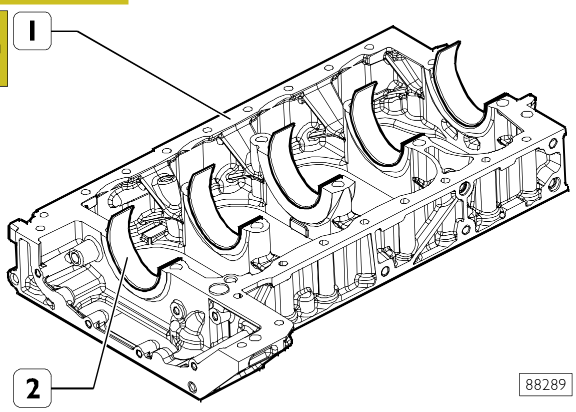
Apply tool 99340060 (2) to the rear O-ring (1) and extract it from the crankcase.

Figure 3



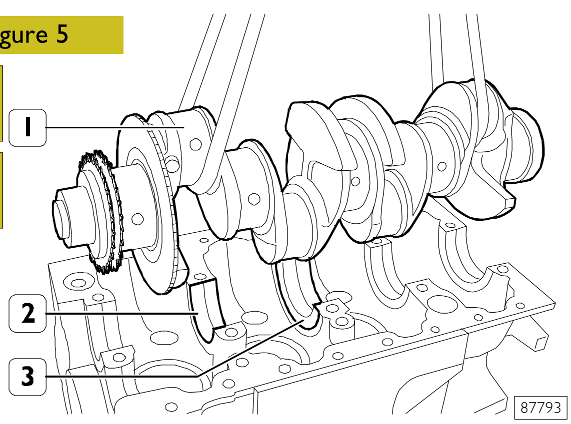
Remove the screws (2) and take off the oil sump (1) with its gasket and frame (3).

Figure 4



NOTE Note the assembly position of the top main bearing shells (2) since, if they are reused, they will need to be fitted in the position found during removal.

Figure 5

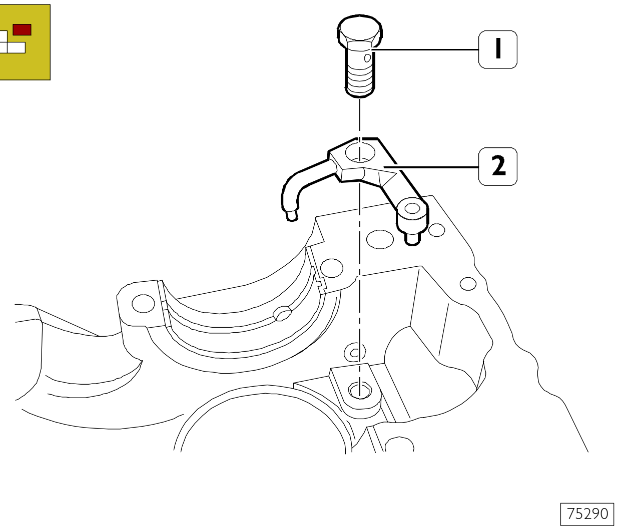


With the aid of a hoist and a rope, remove the crankshaft (1).

NOTE Note the assembly position of the top main bearing shells (2) since, if they are reused, they will need to be fitted in the position found during removal.

The central half-bearing (3) is fitted with shoulder half-rings.

Figure 6

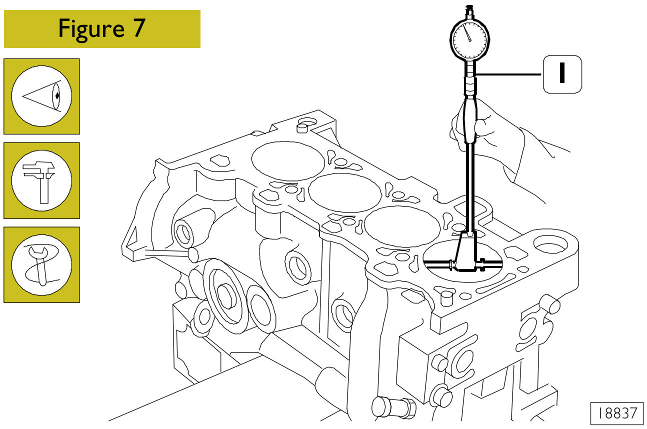


Take out the couplings (1) and remove the oil jets (2).

NOTE On completing engine removal, it is necessary to clean the removed parts thoroughly and check their integrity.
The following pages give the instructions for the main checks and measurements to make in order to determine whether the parts can be reused.

REPAIRS
CYLINDER BLOCK
Checks and measurements

Figure 7

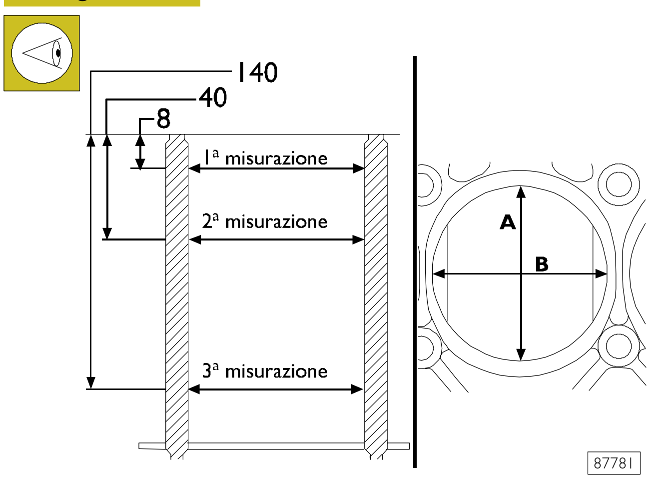


Once the engine removal is complete, carefully clean the cylinder block. For the cylinder block transportation use the suitable rings.

Carefully check that the crankcase has no cracks in it.

Check the state of the plugs. If they are rusty or there is any doubt about their seal, replace them. Examine the surfaces of the cylinder liners; they must show no sign of meshing, scoring, ovalization, taper or excessive wear. The inside diameter of the cylinder liners is checked, to ascertain the extent of ovalization, taper and wear, using the bore meter 99395687 (1) fitted with a dial gauge previously reset on the ring gauge of the diameter of the cylinder liner or on a micrometer.

Figure 8



The measurements must be made for each single cylinder at three different heights up the liner and on two planes at right angles to each other: one parallel to the longitudinal axis of the engine (B) and the perpendicular (A); the greatest wear is generally found on this last plane with the first measurement.

On finding ovalization, taper or wear, go ahead and bore/grind and finish the face of the cylinder liners. The refacing of the cylinder liners should be done in relation to the diameter of the pistons supplied as spare parts oversized by 0.4 mm of the nominal value and to the prescribed assembly clearance.

Figure 9

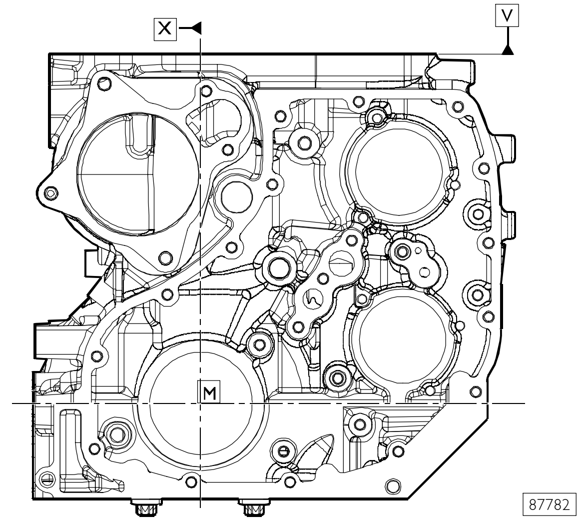
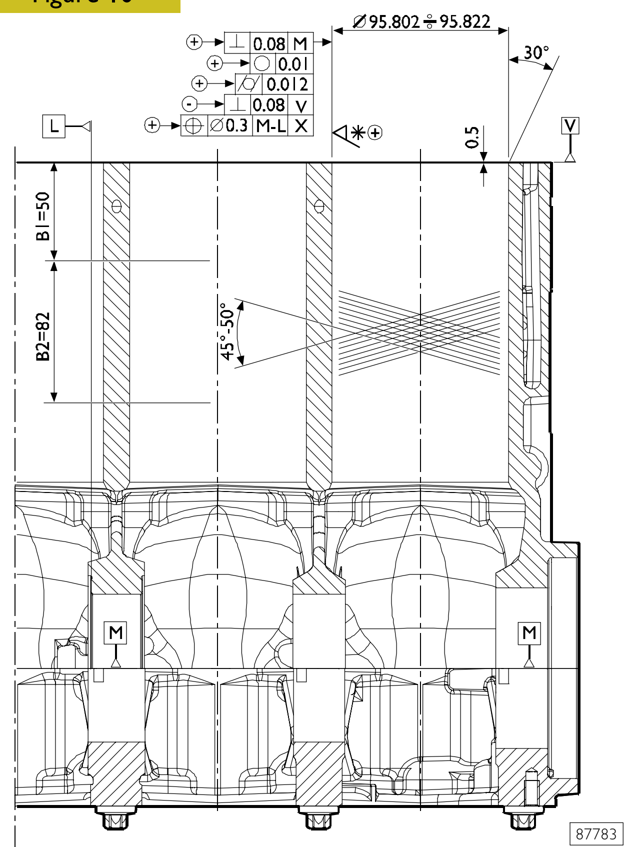


Figure 10



* Surface roughness parameters:

R1 = 4 ÷ 10 μm
Rz = 3 ÷ 8 μm
Ra = 0,3 ÷ 0,6 μm
W1 < 2 μm

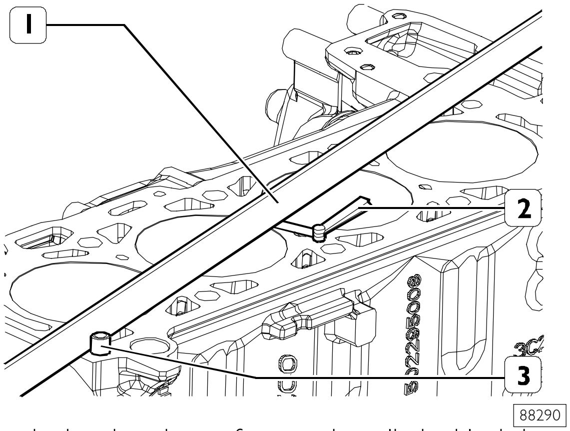
Permissible surface porosity for machined cylinder (see Figure 10)

ZONE B1 = Area of greatest mechanical stress, segment/liner contact: No.2 non-continuous porosities are permissible max. 0.5x0.5. C 100%

ZONE B2 = Surface involved in segment rubbing: No.2 non-contiguous porosities are permissible max. 1x0.8. C 100%

Checking head mating surface on cylinder block

Figure 11

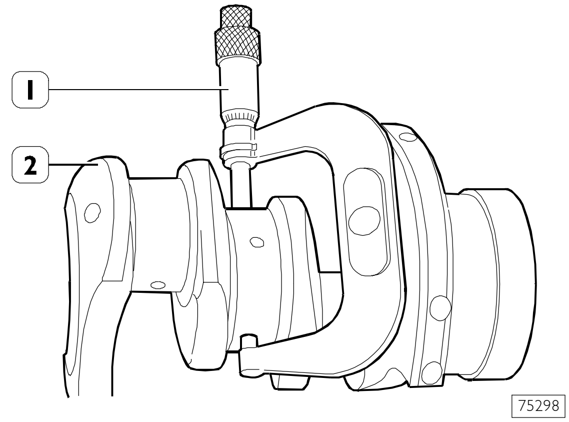


See that the head mating surface, on the cylinder block, has no deformation.
This check can be made, after taking out the grub screws (3), with a surface plate spread with carbon black or with a calibrated rule (1) and a feeler gauge (2). After ascertaining the areas of deformation, level the bearing surface with a grinding machine.

NOTE The crankcase can only be surfaced after making sure that, on completing the work, the piston protrudes from the cylinder liner by no more than the prescribed value.

CRANKSHAFT
Measuring main journals and crank pins

Figure 13



On finding signs of seizure, scoring or excessive ovalization on main journals and crankpins, it is necessary to regrind the pins. Before grinding the pins (2), measure the shaft pins with a micrometer (1) to establish to what diameter it is necessary to decrease the pins.

NOTE It is advisable to enter the measurements in a table. See Figure 12.

Figure 12

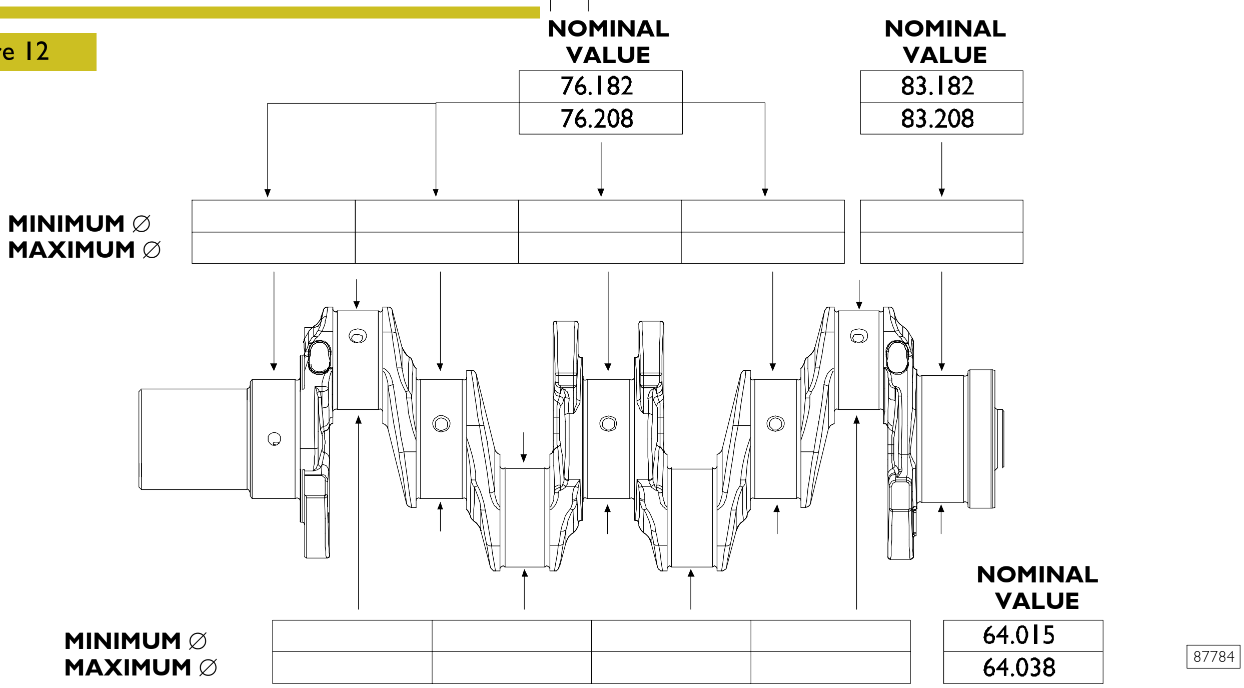


TABLE IN WHICH TO ENTER THE MEASUREMENTS OF THE CRANKSHAFT MAIN JOURNALS AND CRANKPINS

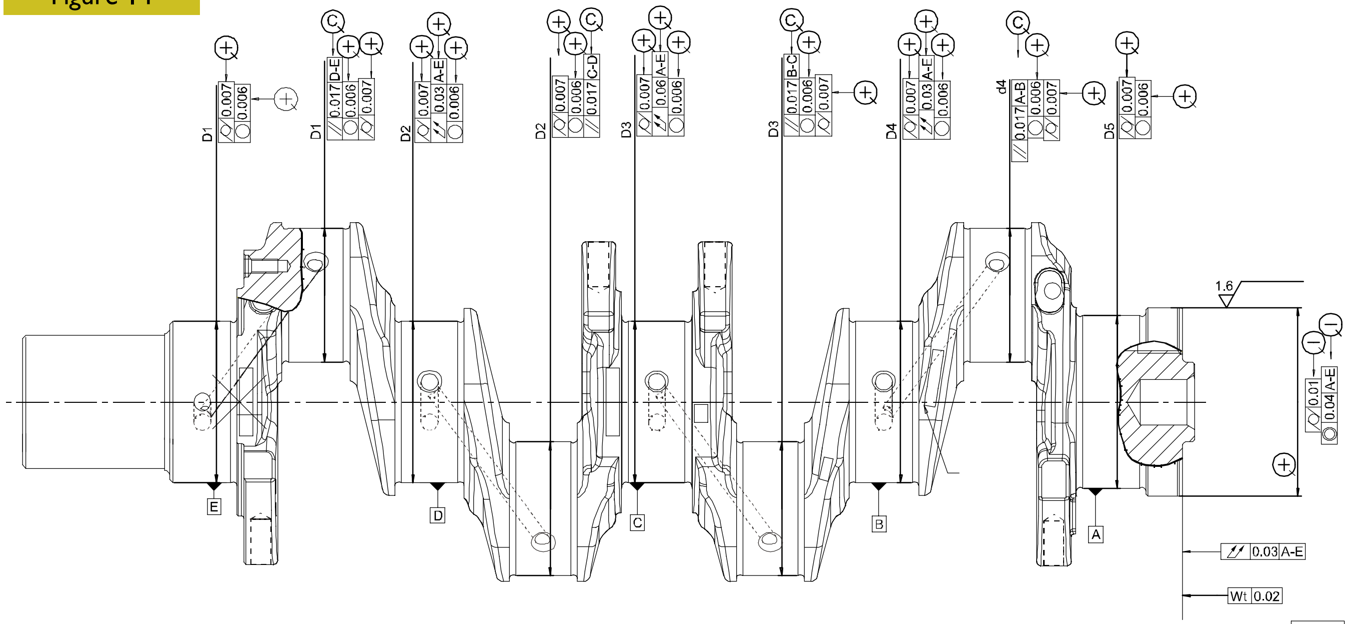
NOTE The main journals and crankpins must always be ground to the same undersize class.
The undersizing performed, on the main journals or crankpins, must be marked by punching on the side of crank arm no. 1.

For undersized crankpins, letter M.
For undersized main journals, letter B.
For undersized crankpins and main journals, letter MB.

The undersize classes are:
0.254 – 0.508 mm.

Checking crankshaft

Figure 14

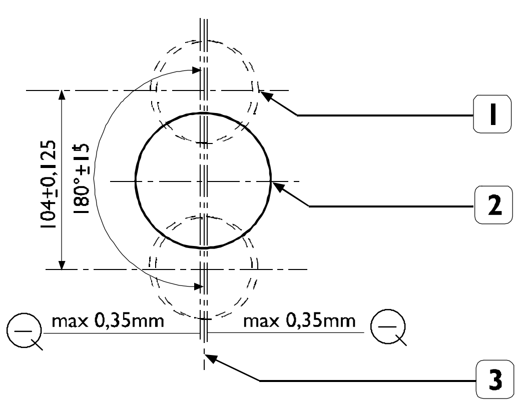


MAIN CRANKSHAFT TOLERANCES

TOLERANCES	TOLERANCE CHARACTERISTIC	GRAPHIC SYMBOL
SHAPE	Circularity	○
	Cylindricality	⌭
ORIENTATION	Parallelism	//
	Perpendicularity	⊥
POSITION	Concentricity or coaxiality	◎
OSCILLATION	Circular oscillation	↗
	Total oscillation	⌰

CLASS OF IMPORTANCE ASCRIBED TO THE PRODUCT CHARACTERISTICS	GRAPHIC SYMBOL
CRITICAL	©
IMPORTANT	⊕
SECONDARY	⊖

Figure 15



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NOTE The checks on the tolerances indicated in the figures must be made after grinding the crankshaft pins.

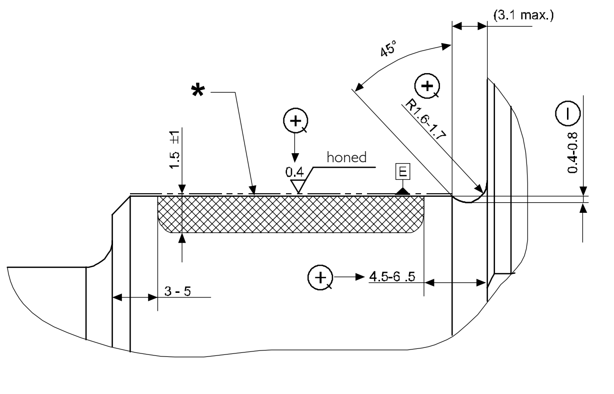
SYMMETRY BETWEEN MAIN JOURNALS AND CRANKPINS
1. Crankpins
2. Main journals
3. Normal position

After grinding, keep to the following:

- ❑ Round off the edges of deburring the holes for lubrication of the main journals and crankpins.

JOURNAL ON TIMING SYSTEM SIDE

Figure 16



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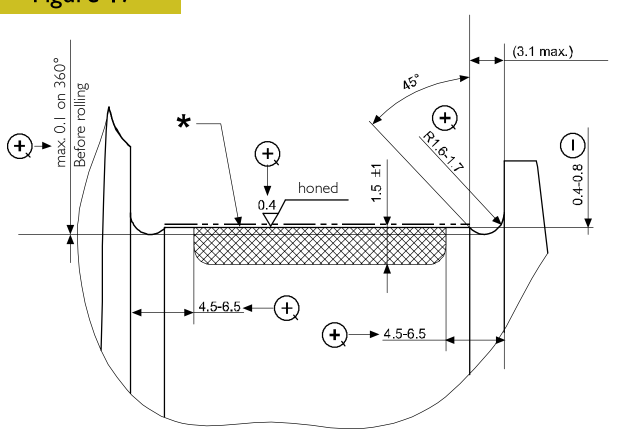
INTERMEDIATE JOURNALS No. 2-4

Figure 17



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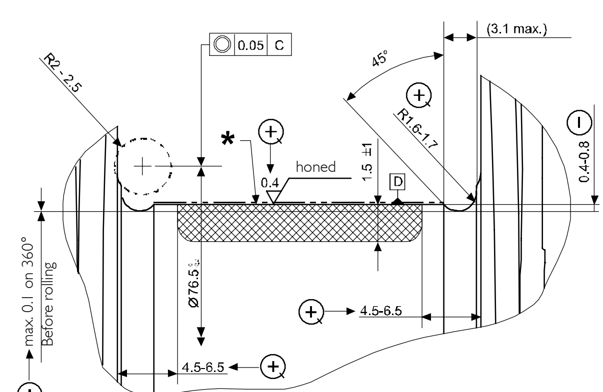
INTERMEDIATE JOURNAL No. 3

Figure 18



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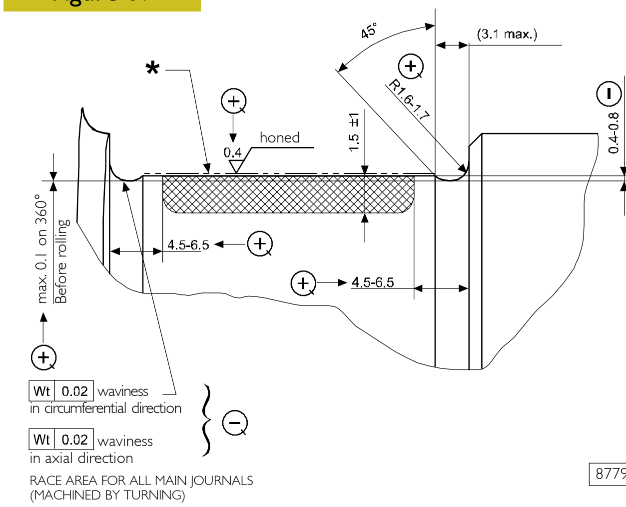
MAIN DATA OF MAIN JOURNALS AND CRANKPINS

JOURNAL ON FLYWHEEL SIDE

Figure 19



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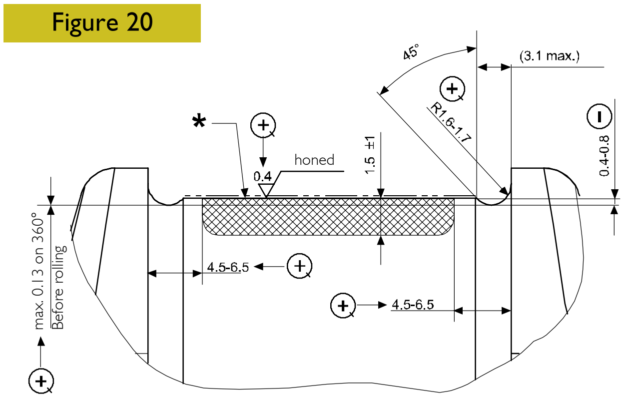
CRANKPINS

Figure 20



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* As far as both values are concerned, for the whole 360°.

NOTE Since, during the 0.254 and 0.508 mm undersizing on the diameter of the crankpins and main journals, the rolled portion of the side races of the pins may get involved, it is necessary to turn the races keeping to the data given in the figure and to do the rolling keeping to the following instructions.

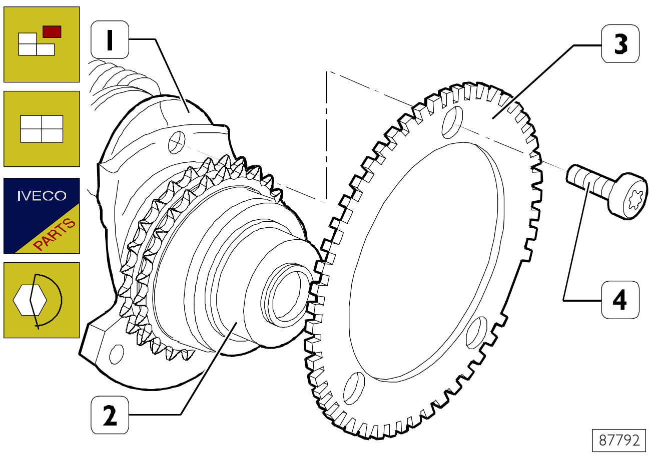
Rolling force:

- 1st main journal 925 ±25 daN.
- 2nd – 3rd – 4th – 5th main journal 1850 ±50 daN.
- crankpin 1850 ±50 daN.

- Rolling turns: 3 approach, 12 effective, 3 out.
- Rolling speed: 56 rpm.
- Reduction of the connecting rod pin slot diameter after rolling: 0.15 ÷ 0.30 mm*.
- Reduction of the journal slots after rolling: 0.15 ÷ 0.30 mm.

* Measured with calibrated rollers ∅ 2.5 mm.

Figure 21



Take out the screws (4) and replace the phonic wheel (3). The screws (4) are coated with LOCTITE 218 and must be replaced with fresh ones after each disassembly.
They must be tightened to a torque of 10 ± 1 Nm.

Replacing timing control gear

On finding the timing control gear teeth (1) damaged or worn, remove them from the crankshaft (2) using a suitable extractor.

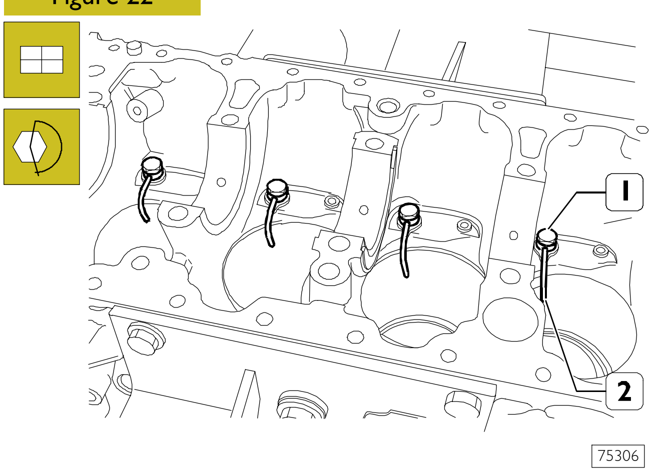
The new gear is fitted onto the crankshaft by heating it to a temperature of 180°C for no longer than 15 minutes.

On completing assembly and after the gear has cooled, it must withstand a torque of 150 Nm without slipping.

ENGINE ASSEMBLY

The following parts must be replaced with new ones at the time of assembly: retaining rings, seals and gaskets, screws whose thread is coated with sealant.

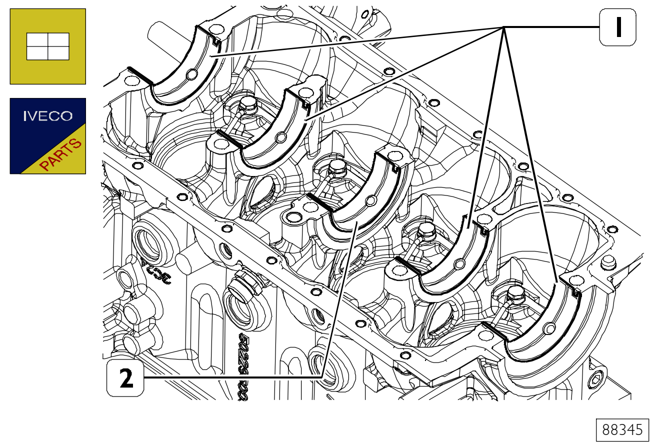
Figure 22



Fit on the oil spray nozzles (2) and tighten the couplings (1) to the prescribed torque.

Assembling main bearings

Figure 23



NOTE Not having found it necessary to replace the main bearings, they need to be fitted back on in the same sequence and position found upon disassembly.

The main bearings (1) are supplied as spare parts undersized on the inside diameter by 0.254 ÷ 0.508 mm.

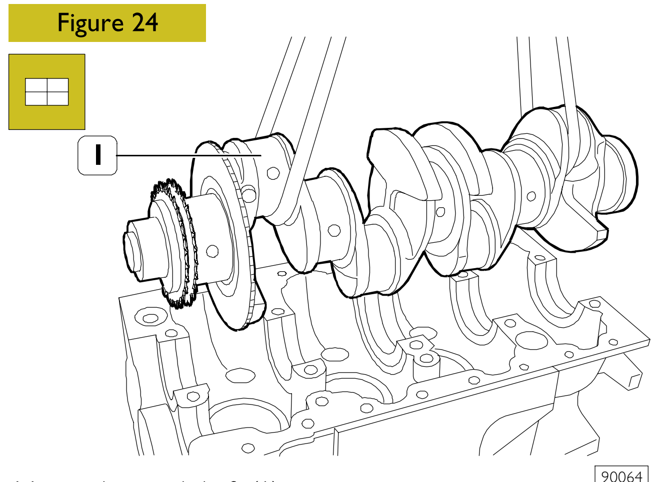
NOTE Do not do any accommodating on the bearings.

Thoroughly clean the top main bearing shells (1) and position them in the crankcase.

NOTE The middle half ring (2) is fitted with thrust washers.

Measuring main journal assembly clearance

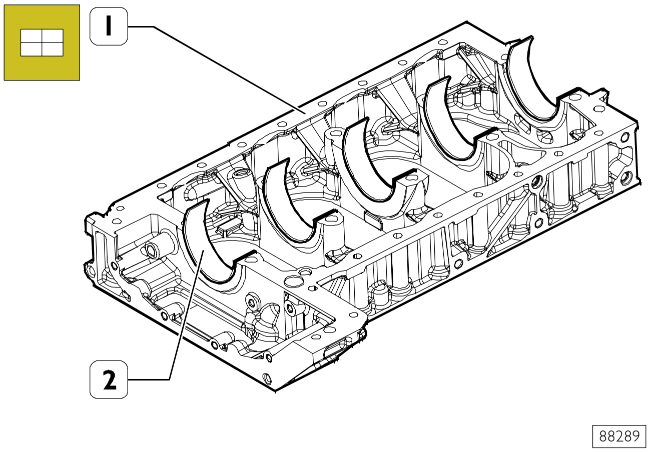
Figure 24



Mount the crankshaft (1).
Check the clearance between the crankshaft main journals and their respective bearings by proceeding as follows:

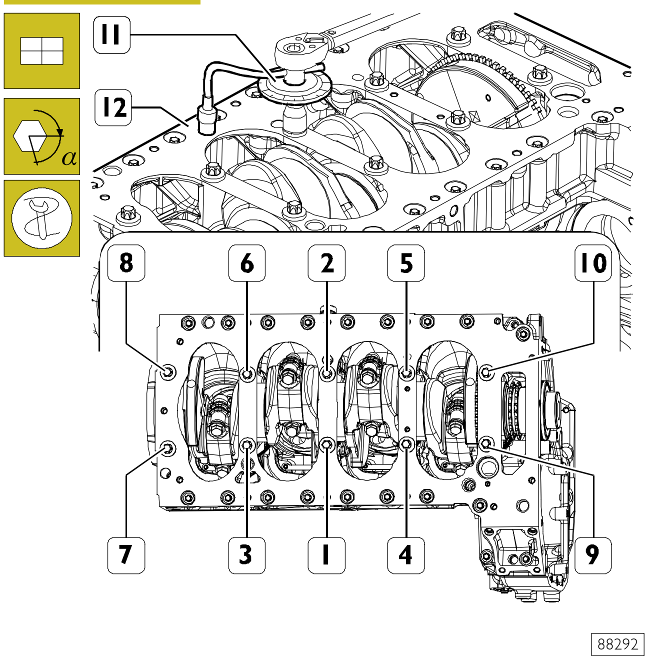
- ❑ Thoroughly clean the pins.
- ❑ Apply a calibrated wire onto the main journals.

Figure 25



Thoroughly clean the bottom main bearing shells (2) and mount them in the crankcase base (1).

Figure 26



Mount the crankcase base (12).

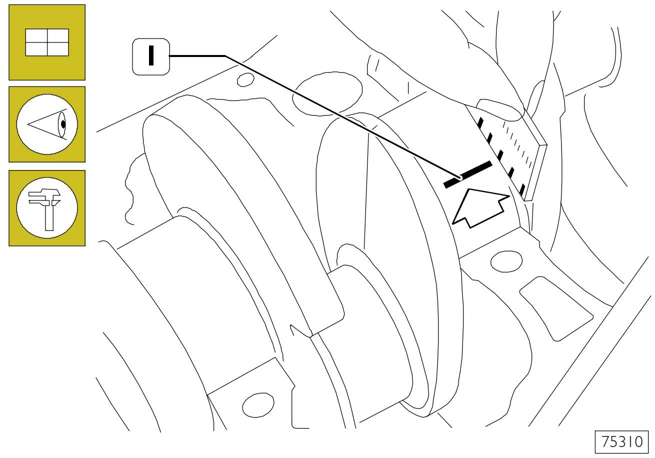
Tighten the screws in the sequence shown in the figure in three steps:

- ❑ Step 1: with a torque wrench, to a torque of 50 Nm.
- ❑ Step 2: closing to an angle of 60°.
- ❑ Step 3: closing to an angle of 60°.

NOTE Use tool 99395216 (11) for the angle closing.

Then tighten the outer screws to torque 26 Nm.

Figure 27

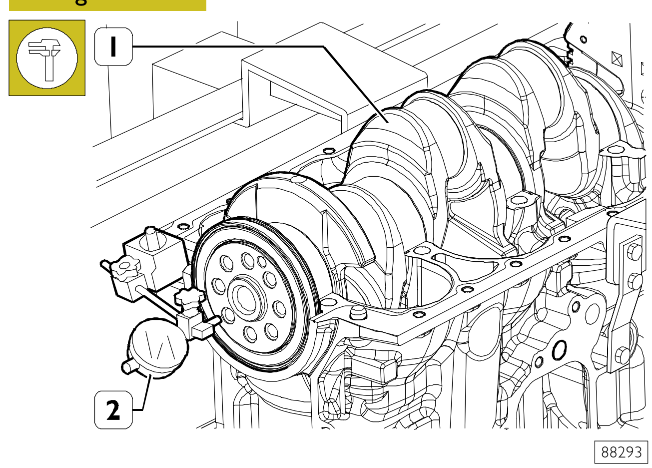


- ❑ Remove the bottom crankcase.

The clearance between the main bearings and their associated pins is measured by comparing the length of the calibrated wire (1), at the point of greatest crushing, with the graduated scale on the casing containing the calibrated wire. The numbers on the scale indicate the clearance of the coupling in millimetres, which must be 0.032 ÷ 0.102 mm. If the clearance is not as prescribed, replace the bearings and repeat the check.

Checking crankshaft end float

Figure 28



The end float is checked by setting a dial gauge (2) with a magnetic base on the crankshaft (1) as shown in the figure. The normal assembly clearance is 0.060 – 0.310 mm.

If you find the clearance to be greater than as required, replace the rear main bearing shells carrying the thrust bearings and repeat the clearance check between the crankshaft pins and the main bearing shells.

If the end float of the crankshaft does not come within the prescribed values, it is necessary to grind the crankshaft and accordingly change the main bearing shells.

NOTE: The middle main bearing has half thrust washers integrated in it, so it performs the function of a thrust bearing. It is supplied as a spare part only with the normal shoulder thickness.

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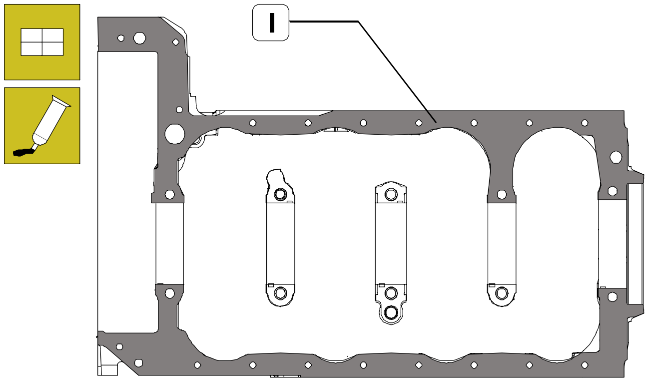
Figure 29

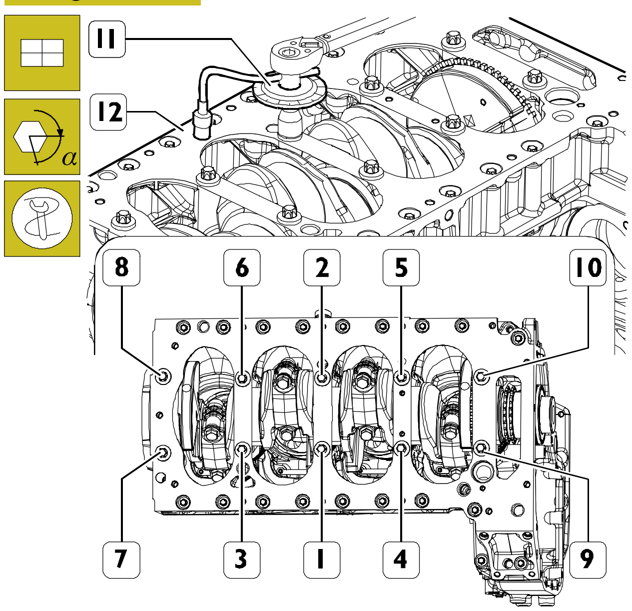


88294

Thoroughly clean the crankcase / crankcase base mating surface.
Apply, on base, sealant LOCTITE 510 IVECO no. 93162432, as indicated in the scheme. The sealant must result to be even, not patchy.

NOTE Mount the crankcase base within 10 minutes of applying the sealant.

Figure 30



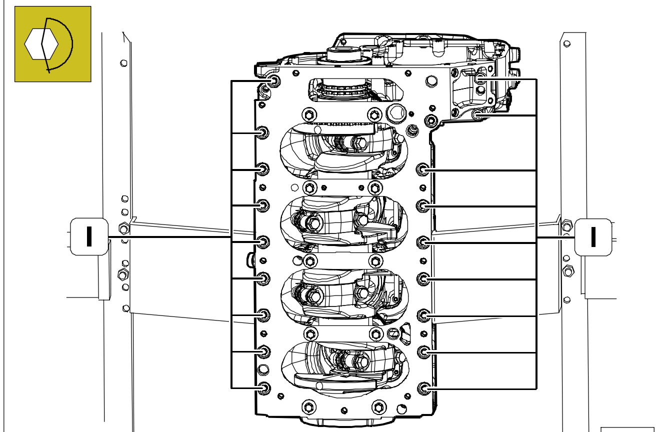
88292

Mount the crankcase base (12) and tighten the fixing screws in three stages, following the sequence shown in the figure:

- ❑ Step 1: with a torque wrench, to a torque of 50 Nm.
- ❑ Step 2: closing to an angle of 60°.
- ❑ Step 3: closing to an angle of 60°.

NOTE Use tool 99395216 (11) for the angle closing.

Figure 31

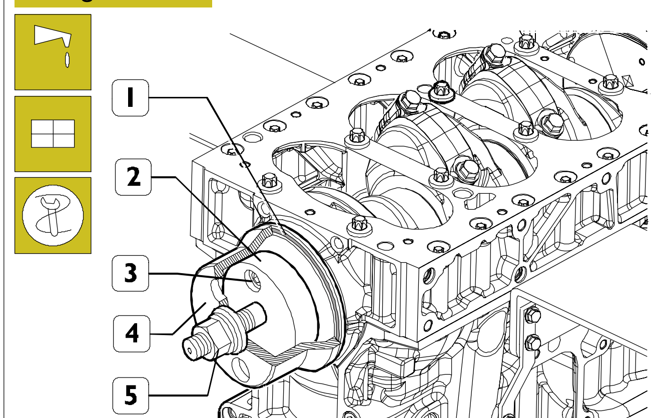


88296

Then tighten the outer screws (1) to a torque of 26 – 30 Nm.

Assembling rear seal

Figure 32

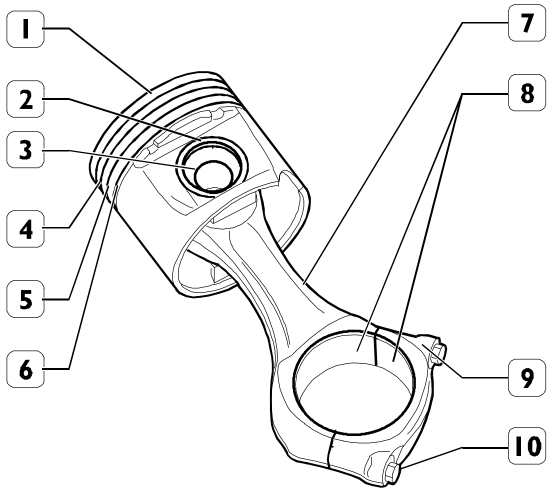


88297

Carefully clean the seal seat.
Lubricate the rear shank of the crankshaft with engine oil.
Fit part (2) of tool 99346259 onto the rear shank of the crankshaft; secure it with the screws (3) and key the fresh seal (1) onto it.
Position part (4) on part (2); screw down the nut (5) to fit the seal (1) fully inside the crankcase.

CONNECTING ROD – PISTON ASSEMBLY

Figure 33



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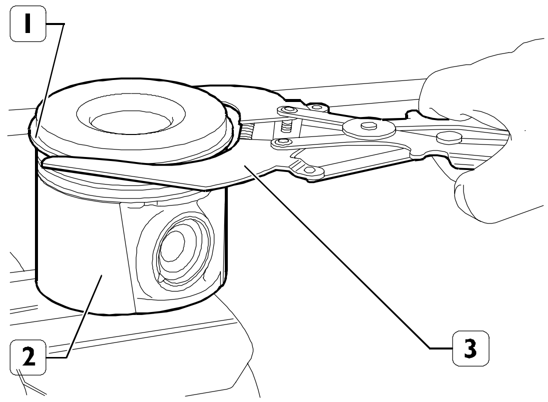
PISTON – CONNECTING ROD ASSEMBLY
1. Piston – 2. Piston ring – 3. Pin – 4. Trapezoidal ring – 5. Oil scraper ring – 6. Slotted oil scraper ring with spiral spring – 7. Connecting rod body – 8. Bearing shells – 9. Connecting rod cap – 10. Cap fixing screws.

Check the pistons. They must show no signs of seizure, scoring, cracking or excessive wear; replace them if they do.

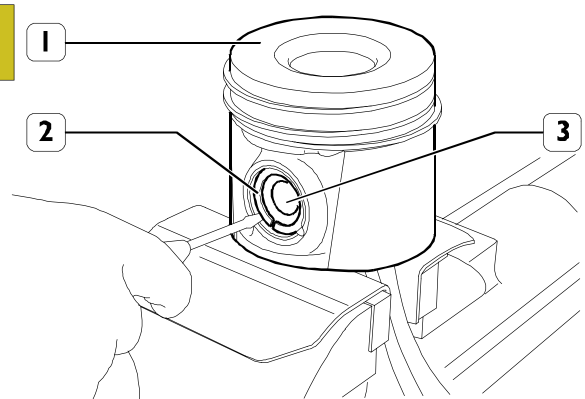
Figure 34



75393

Remove the piston rings (1) from the piston (2) using pliers 99360183 (3).

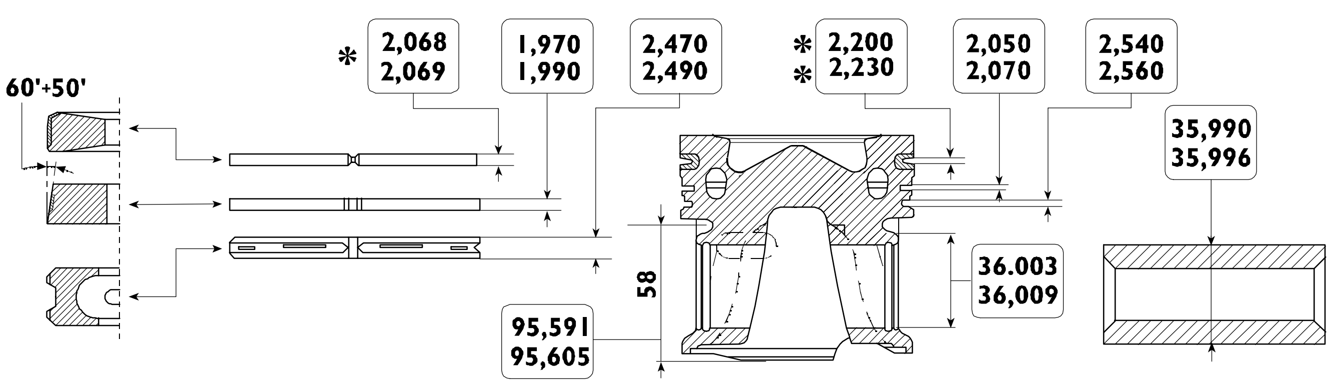
Figure 35



75394

Remove the piston (1) from the connecting rod, taking out the piston ring (2) and extracting the pin (3).

Figure 36



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MAIN DATA FOR MONDIAL PISTON, PINS AND PISTON RINGS

* The value is measured at 1.5 mm from the outer diameter

** The value of the diameter measured is 91.4 mm

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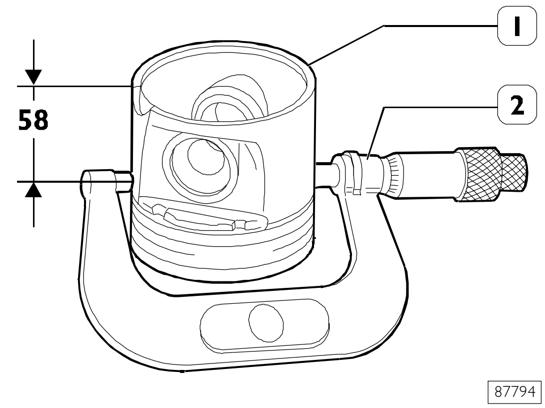
Pistons

Measuring piston diameter

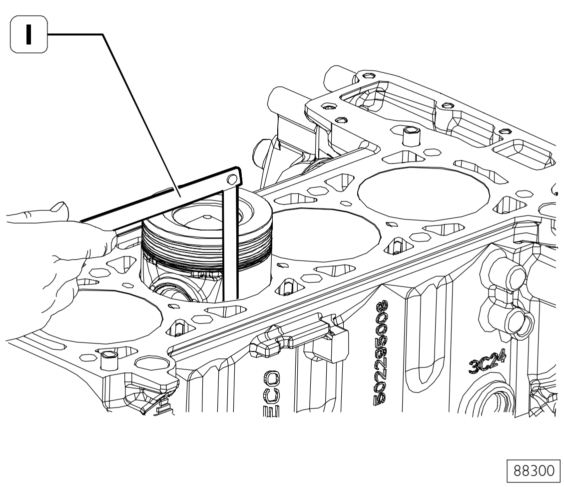
Figure 37



Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance. The diameter has to be measured at the value shown.

NOTE The pistons are supplied as spare parts with the standard, normal and 0.4mm oversize diameters together with rings, pin and retaining rings.

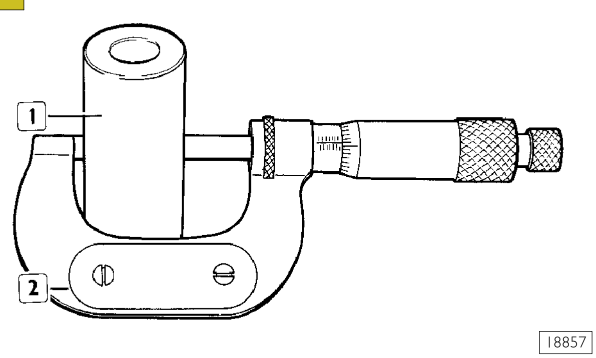
Figure 38



The clearance between the piston and cylinder liner can also be checked using a feeler gauge (1) as illustrated in the figure.

Piston pins

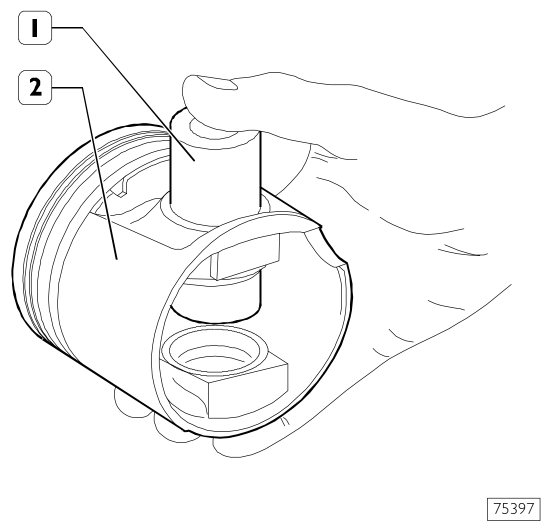
Figure 39



Measuring the diameter of the piston pin (1) with a micrometer (2).

Conditions for correct pin-piston coupling

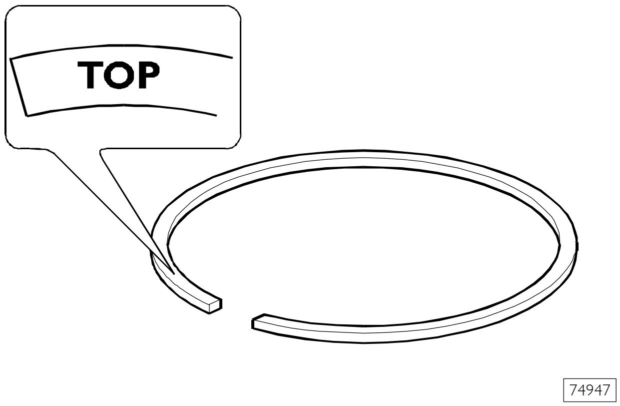
Figure 40



Lubricate the pin (1) and its seat on the hubs of the piston (2) with engine oil. The pin must go into the piston by lightly pressing with the fingers and must not drop out by gravity.

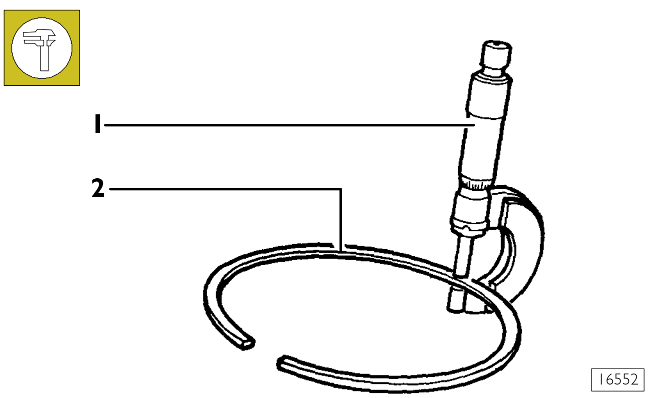
Piston rings

Figure 41



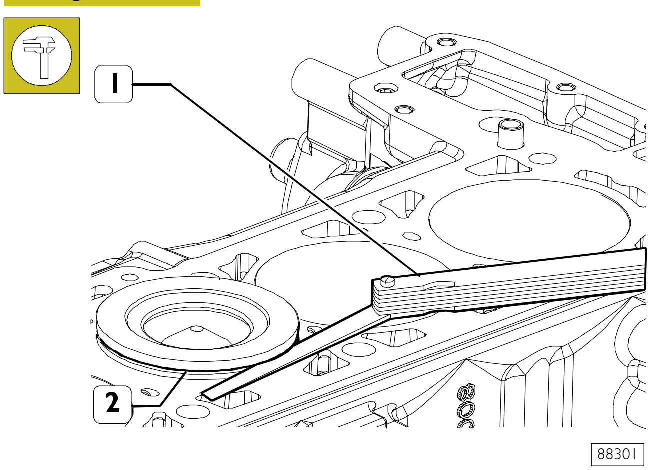
The trapezoidal split rings (1st slot) and the oil scraper rings (2nd slot) have the word TOP etched in them; when fitting them on the piston, the word TOP must be facing upwards.

Figure 42



Check the thickness of the piston rings (2) with a micrometer (1).

Figure 43



Check the clearance between the trapezoidal ring (2) (1st slot) and the associated slot on the piston with a feeler gauge (1), proceeding as follows: insert the piston into the cylinder liner so that the ring (2) comes approximately half way out of it.

Figure 44

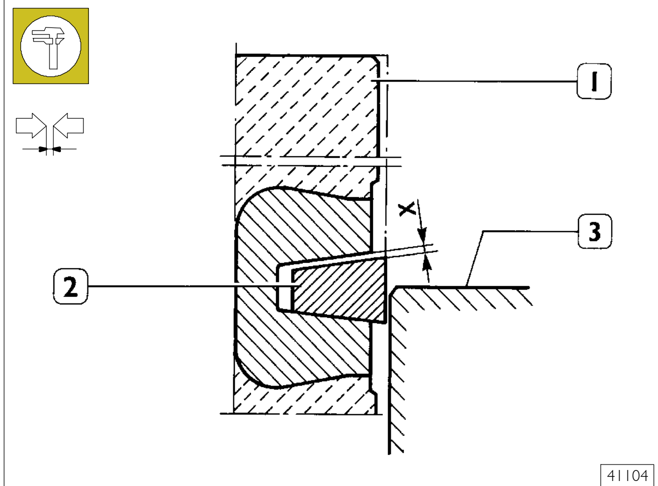
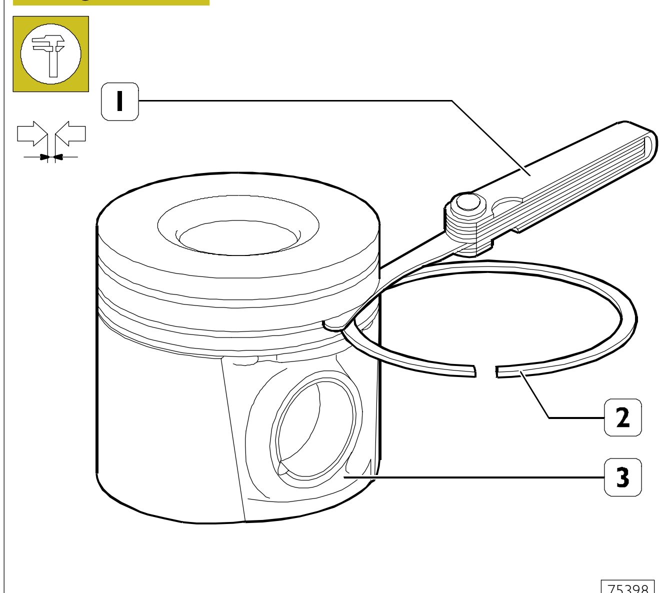


DIAGRAM FOR MEASURING THE CLEARANCE X BETWEEN THE FIRST PISTON SLOT AND THE TRAPEZOIDAL RING
1. Piston slot – 2. Trapezoidal piston ring – 3. Cylinder liner

Using a feeler gauge (1, Figure 43), check the clearance (X) between the ring (2) and the slot (1); this clearance must have the prescribed value.

Figure 45



Check the clearance between the piston rings (2) of the 2nd and 3rd slot and the associated seats on the piston (3) with a feeler gauge (1).

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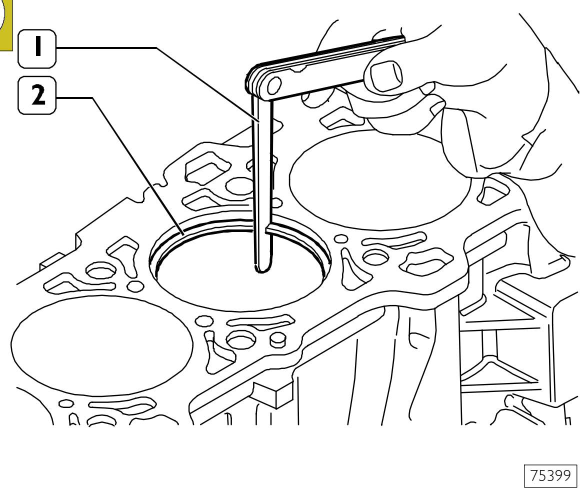
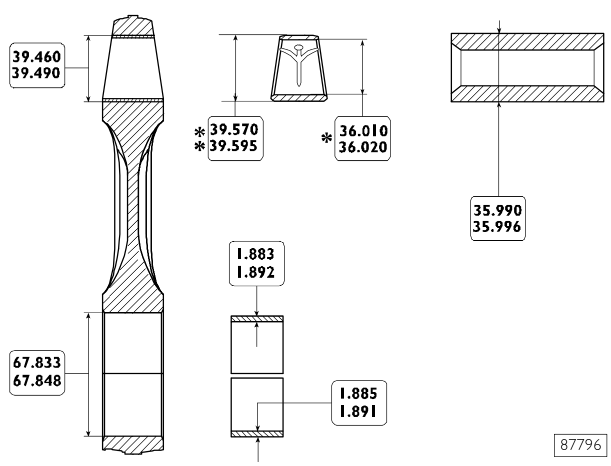
Figure 46



Check the opening between the ends of the piston rings (2) inserted in the cylinder liner using a feeler gauge (1).

Connecting rods

Figure 47



MAIN DATA OF THE CONNECTING ROD, BUSHING, PISTON PIN AND BEARING SHELLS

* Internal diameter to obtain after driving into the small end and grinding with a reamer.

** Dimension cannot be measured in the free state.

*** Thickness of the bearing shell supplied as a spare part.

NOTE Each connecting rod has its cap marked:

- with a letter: O or X indicating the diameter class of the big end mounted in production;
- with a number indicating the weight class of the connecting rod mounted in production.

In addition, it could be stamped with the number of the cylinder in which it is fitted.

In the event of replacement it is therefore necessary to number the new connecting rod with the same number as the one replaced.

The numbering must be done on the opposite side to the bearing shell retaining slots.

The connecting rods are supplied as spare parts with the diameter of the big end 67.833 – 67.848 mm marked with the letter O and the weight class marked with the number 33.

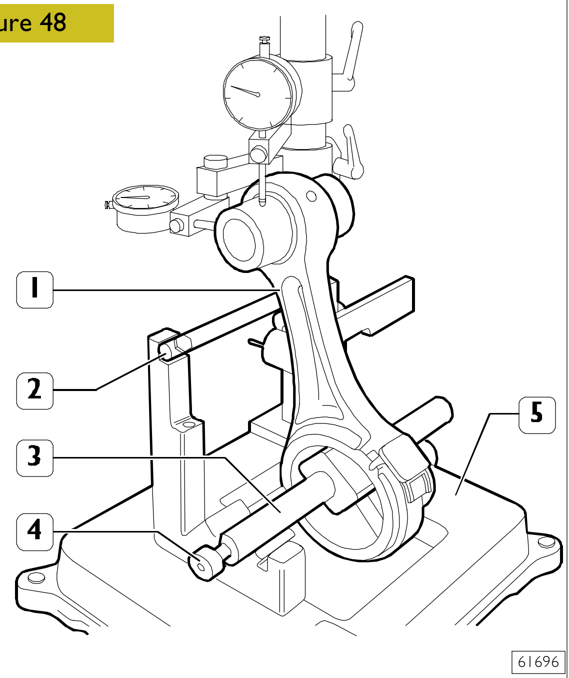
It is not permissible to remove material.

Bushing

Check that the bush in the small end has not come loose and shows no sign of seizure or scoring. If it does, replace the complete connecting rod.

Checking connecting rods

Figure 48

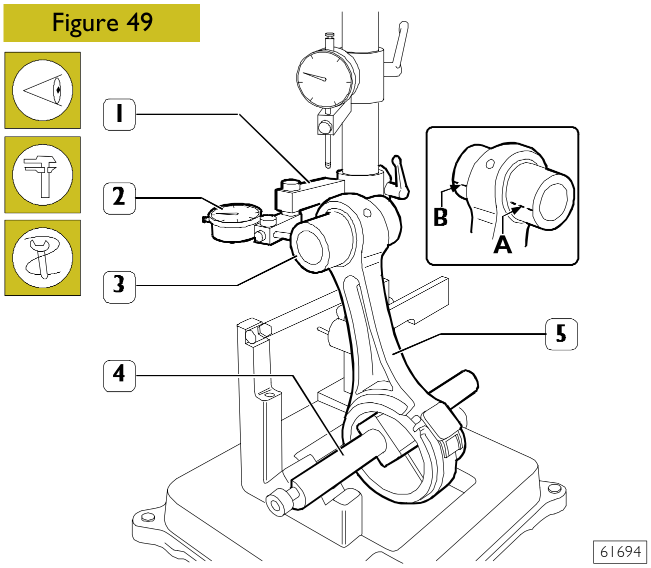


Check the alignment of the axes of the connecting rods (1) with device 99395363 (5), proceeding as follows:

- Fit the connecting rod (1) on the spindle of the tool 99395363 (5) and lock it with the screw (4).
- Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion

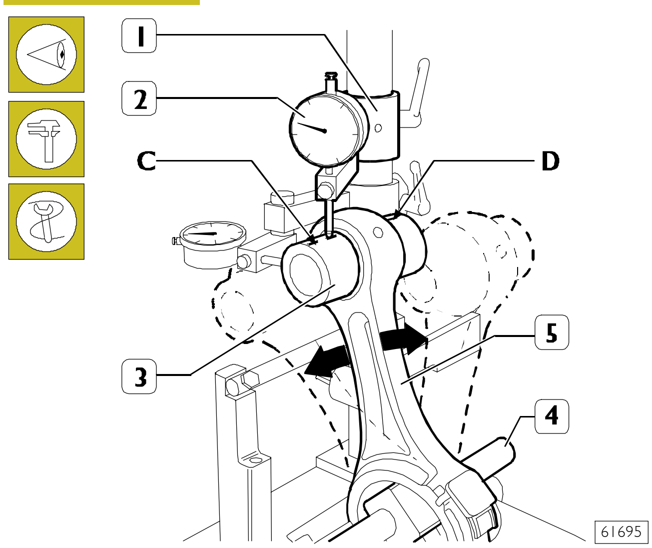
Figure 49



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point A and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side B of the pin (3): the difference between A and B must be no greater than 0.08 mm.

Checking bending

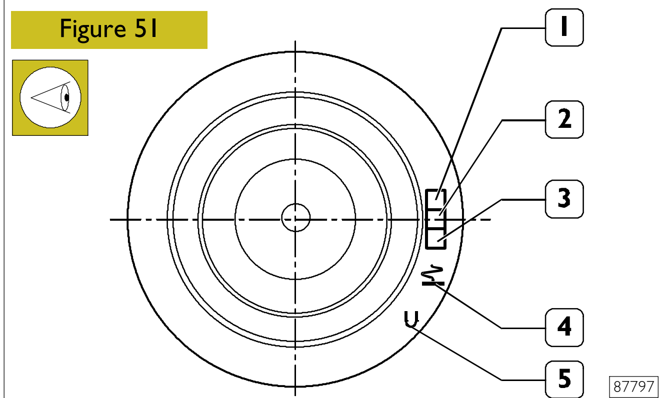
Figure 50



Check the bending of the connecting rod (5) by comparing two points C and D of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point C.
Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2).
Shift the spindle with the connecting rod (5) and repeat the check on the highest point on the opposite side D of the pin (3). The difference between point C and point D must be no greater than 0.08 mm.

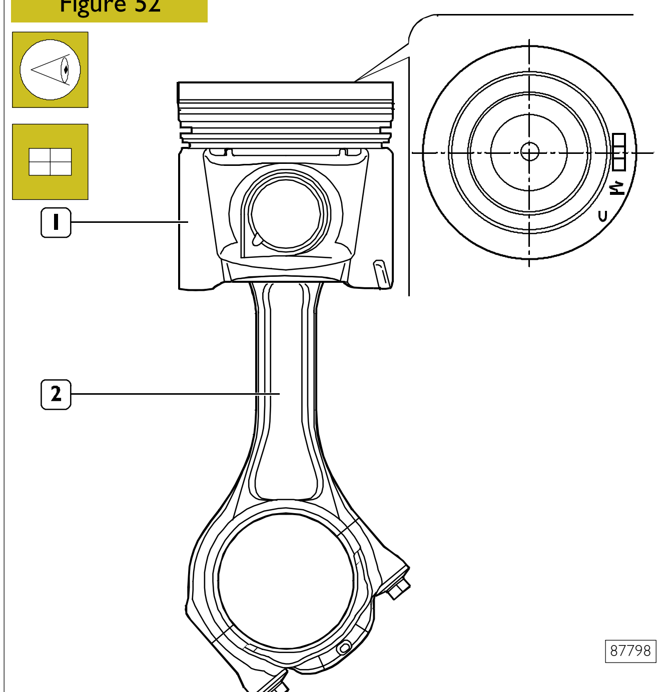
Assembling connecting rod-piston assembly

Figure 51



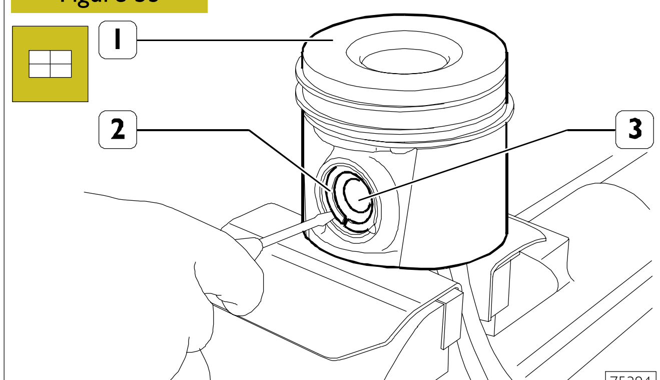
Etched on the top of the piston are: the type of engine (1), class selection (2) and supplier (3) as well as the direction of fitting the piston in the cylinder liner (4). The mark (5) is for passing the 1st slot insert adhesion test.

Figure 52



Connect the piston (1) to the connecting rod (2) together with its cap so that the piston assembly reference, position of the connecting rod and of the cap are observed as shown in the figure.

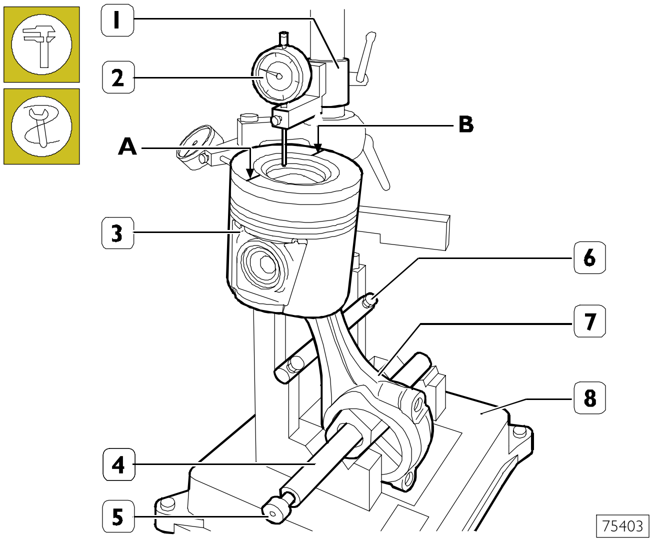
Figure 53



Position the piston (1) on the connecting rod, insert the pin (3) and secure it with the split rings (2).

Checking for connecting rod – piston distortion

Figure 54



After fitting the connecting rod – piston assembly together, check for distortion with the tool 99395363 (8) as follows:

❑ Fit the connecting rod (7) together with the piston (3) on the spindle (4) of tool 99395363 (8) and lock it with the screw (5).

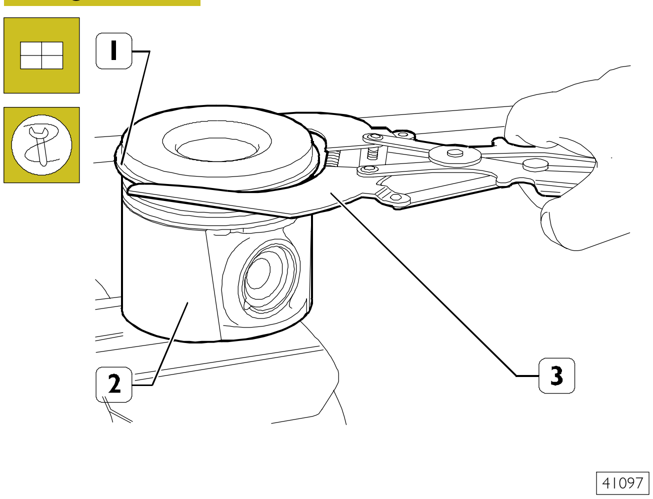
❑ Rest the connecting rod (7) on the bar (6).

❑ Position the mount (1) of the dial gauge (2) so that this is positioned at point A of the piston with a pre-load of 0.5 mm and zero the dial gauge (2).

❑ Shift the spindle (4) so as to position the dial gauge (2) at point B of the piston (3) and check for any deviation.

Assembling piston rings

Figure 55

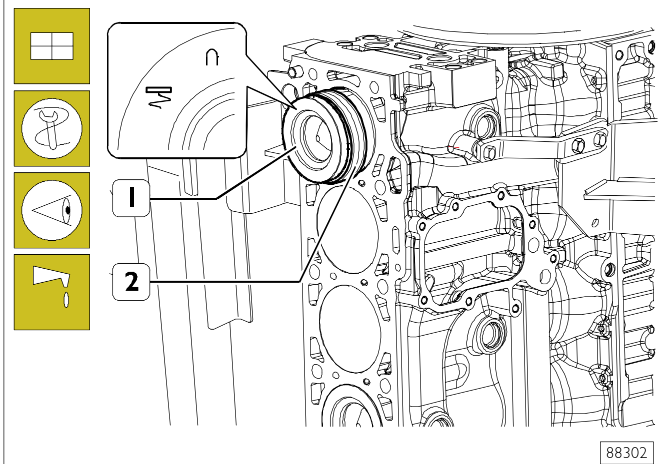


Fit the piston rings (1) on the piston (2) using the pliers 99360183 (3).

NOTE The 1st and 2nd slot rings need to be mounted with the word "TOP" facing upwards.

Assembling connecting rod – piston assemblies in cylinder barrels

Figure 56



Lubricate the pistons well, including the piston rings and the inside of the cylinder liners.
With the aid of the clamp 99360605 (2), fit the connecting rod – piston assembly (1) in the cylinder liners, checking that:

❑ The number of each connecting rod corresponds to the cap mating number.

❑ The openings of the piston rings are staggered 120° apart.

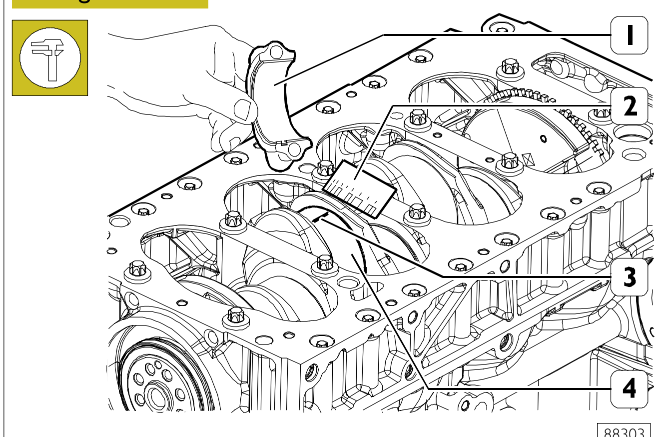
❑ The pistons are all of the same weight.

❑ The symbol punched on the top of the pistons faces the engine flywheel, or the recess in the skirt of the pistons tallies with the oil spray nozzles.

NOTE Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position found on disassembly.

Measuring crankpin assembly clearance

Figure 57

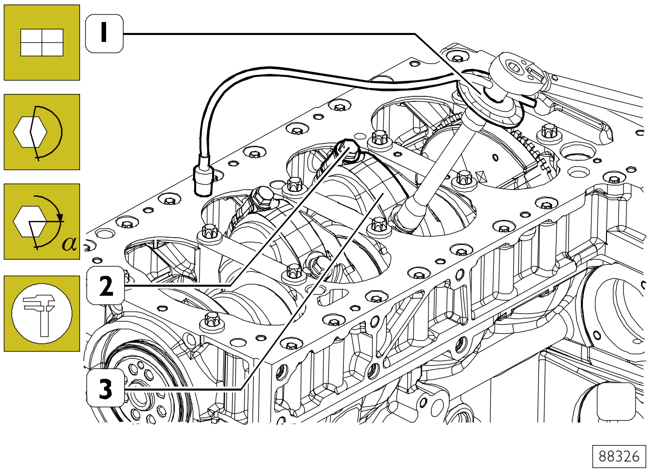


To measure the clearance, carry out the following steps:

❑ Thoroughly clean parts (1) and (4) and eliminate all traces of oil.

❑ Place a length of calibrated wire (3) on the crankshaft pins (4).

Figure 58



- Fit the connecting rod caps (3) with the associated bearing shells.
- Tighten the screws (2) in two steps:
  - Step 1: with a torque wrench, to a torque of 50 Nm.
  - Step 2: closing to an angle of 70°.

NOTE Use tool 99395216 (1) for the angle closing.

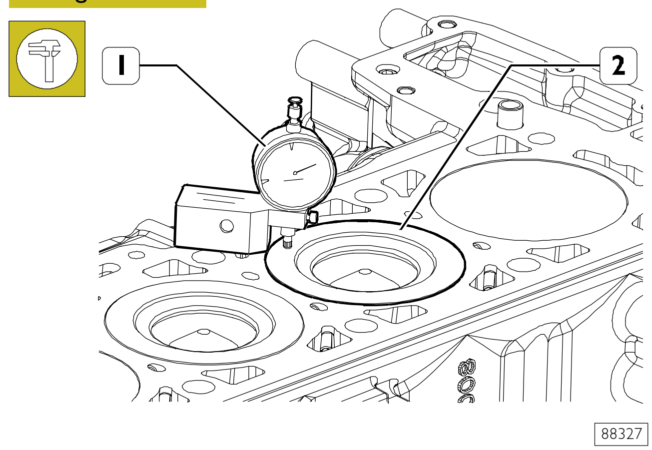
- Remove the cap (3) and determine the existing clearance by comparing the width of the calibrated wire (3, Figure 57) with the graduated scale on the case (2, Figure 57) that contained the calibrated wire. On finding a clearance other than as prescribed, replace the bearing shells and repeat the check.
  On obtaining the prescribed clearance, lubricate the connecting rod bearing shells and fit them permanently by tightening the connecting rod cap fixing screws as described.

NOTE The connecting rod cap fixing screws must always be replaced for permanent assembly.

Manually check that the connecting rods slide axially on the pins of the crankshaft.

Checking piston protrusion

Figure 59



At the end of the connecting rod-piston assembly refitting, check the piston protrusion (2) at the T.D.C. compared to the top level of the cylinder block by means of a dial gauge (1) and relevant base 99370415.

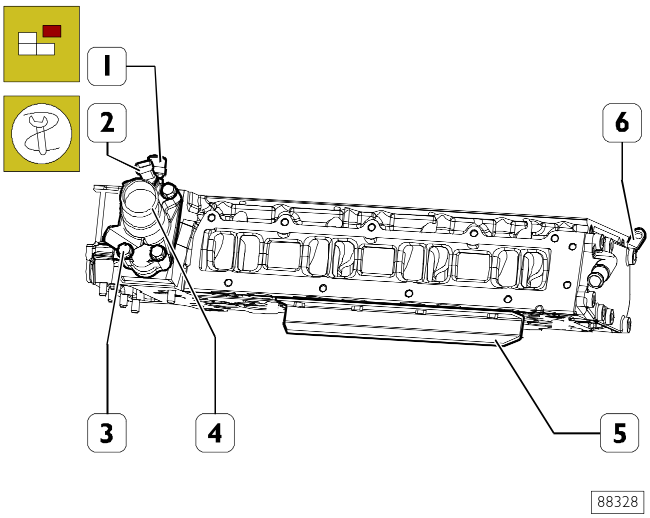
NOTE The difference between the minimum and maximum protrusions of the four pistons must be = 0.15 mm.

The cylinder head gasket in the set of spare gaskets needed for complete engine overhaul is supplied with a single thickness. Clearly, it is supplied separately too.

CYLINDER HEAD

Disassembly

Figure 60



Apply the support SP. 2271 (5) on the cylinder head and tighten the support in a vice.

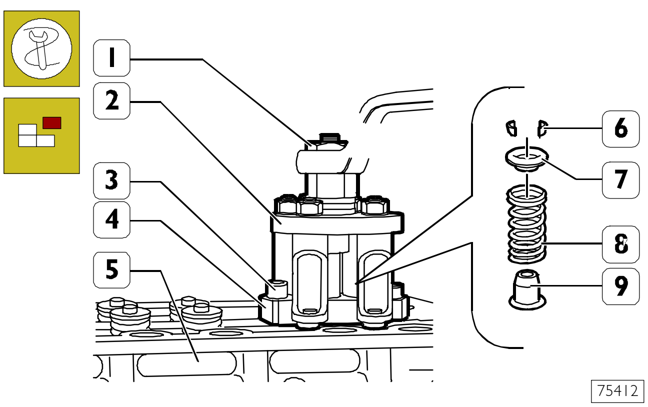
Remove the brackets (6) for lifting the engine.

Remove the sensors (1 and 2), if needed.

Take out the screws (3) and remove the thermostat casing (4).

Disassembling valves

Figure 61



Fit part (4) of tool 99360260 onto the cylinder head (5) and secure it with the screws (3).

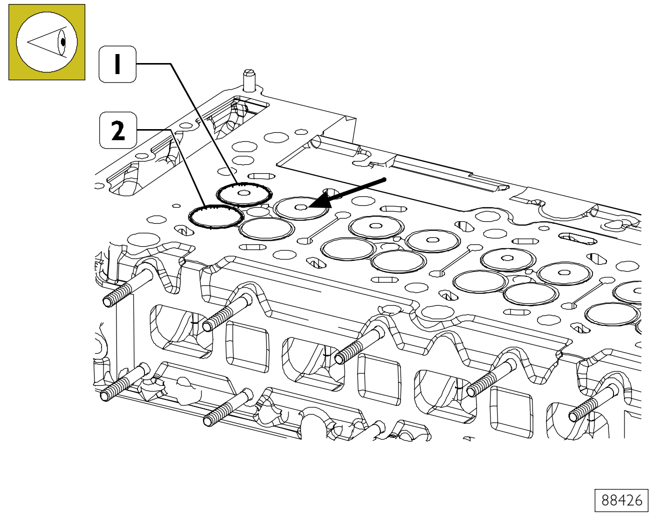
Fit part (2) of tool 99360260 onto part (4), screw down the nut (1) so that on compressing the springs (8) it is possible to remove the cotters (6). Then take out the plates (7) and the springs (8).

Using suitable pliers, remove the oil seal (9).

Repeat these operations on the remaining valves.

Turn the cylinder head over.

Figure 62



The intake (1) and exhaust (2) valves have the same diameter mushroom.

The central cavity (→) of the mushroom of the intake valve (1) is distinguished from that of the exhaust valve (2).

NOTE Before removing the valves from the cylinder heads, number the valves in order to refit them correctly if they are not changed.

A = intake side – S = exhaust side

Remove the intake (1) and exhaust (2) valves.

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Checking cylinder head seal

Check the hydraulic seal using a suitable tool.
Pump in water heated to approx. 90°C at a pressure of 2 ÷ 3 bars.

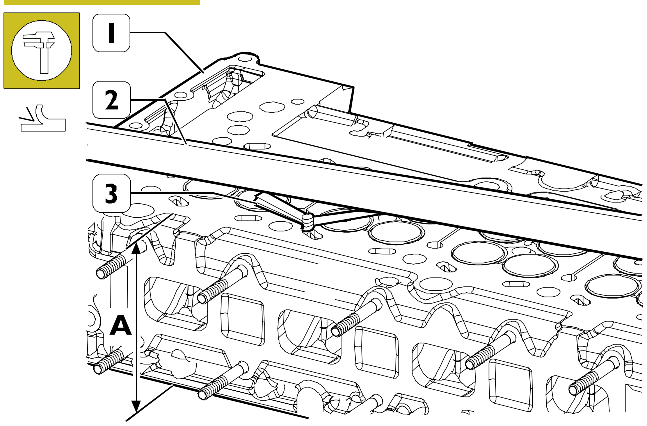
Replace the cup plugs if they are found to leak at oil, using a suitable drift for their removal – assembly.

NOTE Before mounting the plugs, apply LOCTITE 270 water-reacting sealant on their sealing surfaces.

If there is any leakage from the cylinder head, it must be replaced.

Checking cylinder head mating surface

Figure 63



88331

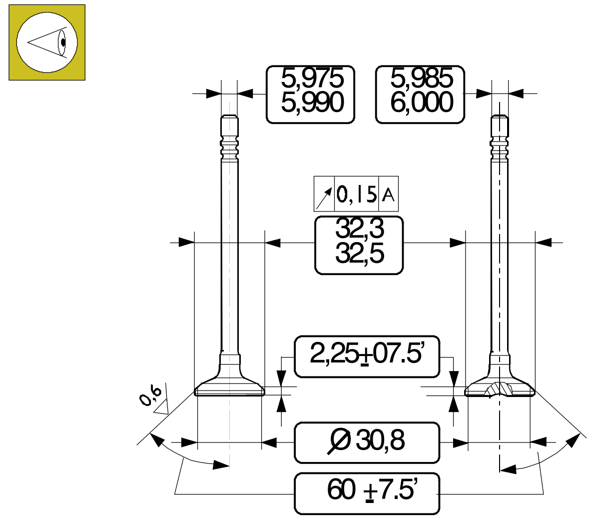
The mating surface of the head (1) with the cylinder block is checked using a rule (2) and a feeler gauge (3).
The deformation found on the entire length of the cylinder head must be no greater than 0.20 mm.
For greater values, regrind the cylinder head according to the values and instructions given in the following figure.

The nominal thickness A of the cylinder head is 112 ±0.1 mm; the maximum permissible removal of metal must not exceed a thickness of 0.2 mm.

NOTE After regrinding, check the valve recessing and if necessary regrind the valve seats to make the prescribed valve recessing.

VALVES

Figure 64

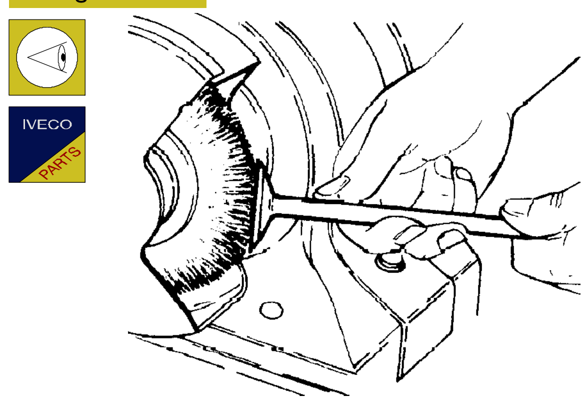


87799

MAIN DATA OF INTAKE AND EXHAUST VALVES

Removing deposits, refacing and checking valves

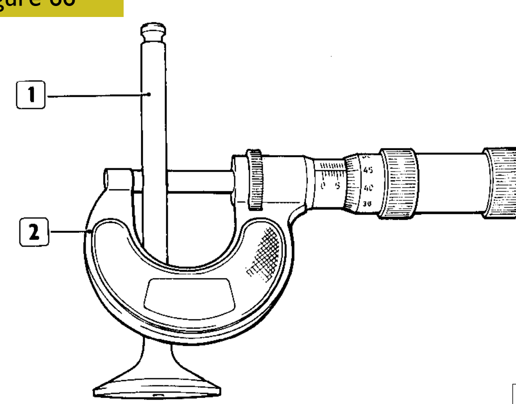
Figure 65



18625

Remove the carbon deposits on the valves with a wire brush.
Check that the valves show no signs of seizure, cracking or burning.

Figure 66

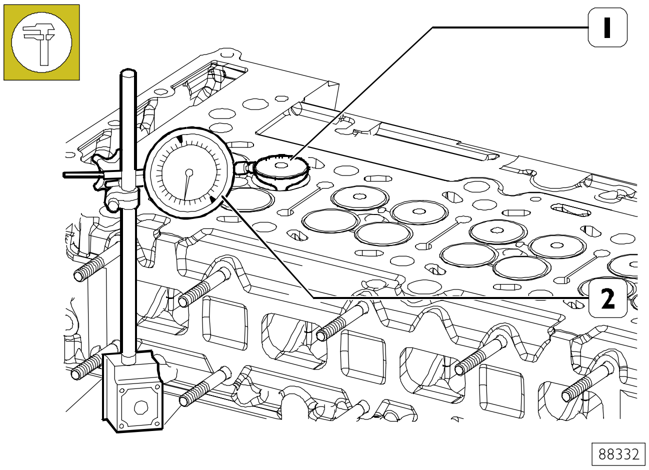


18882

Use a micrometer (2) to measure the valve stem (1): it must have the value shown in Figure 132. If necessary, grind the valve seats by means of the grinding machine 99305018, and remove as little material as possible.

Checking clearance between valve stem and valve guide and centring valves

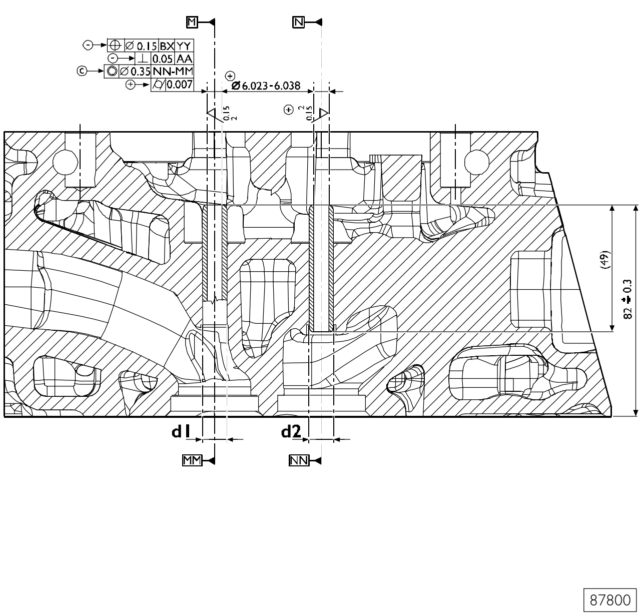
Figure 67



The checks are made using a dial gauge (2) with a magnetic base, positioned as illustrated. The assembly clearance is 0.033 – 0.063 mm.
Making the valve (1) turn, check that the centring error is no greater than 0.03 mm.

VALVE GUIDES
Replacing valve guide

Figure 68

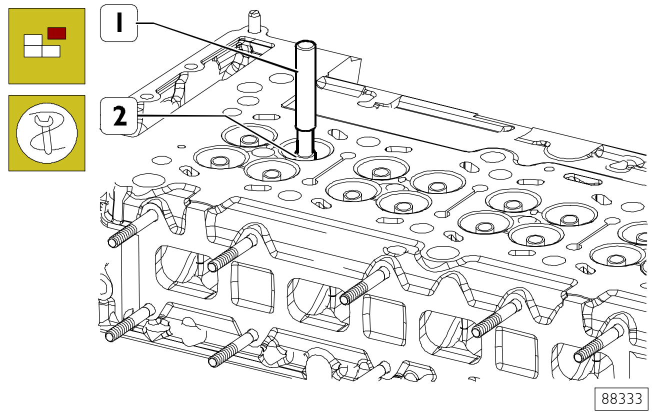


MAIN DATA OF VALVE GUIDES – SEATS

Valve guide seat inside Ø	9.980 ÷ 10.000 mm
Valve guide outside Ø	10.028 ÷ 10.039 mm

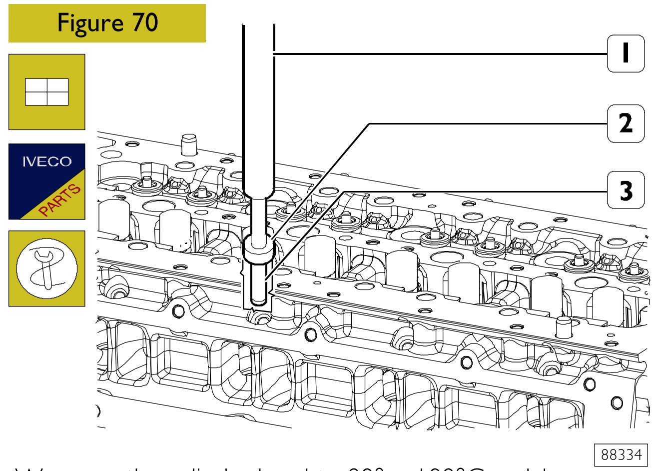
* Measurement to be made after driving in the valve guides.

Figure 69



Remove the valve guides (2) with the drift SP.2312 (1).

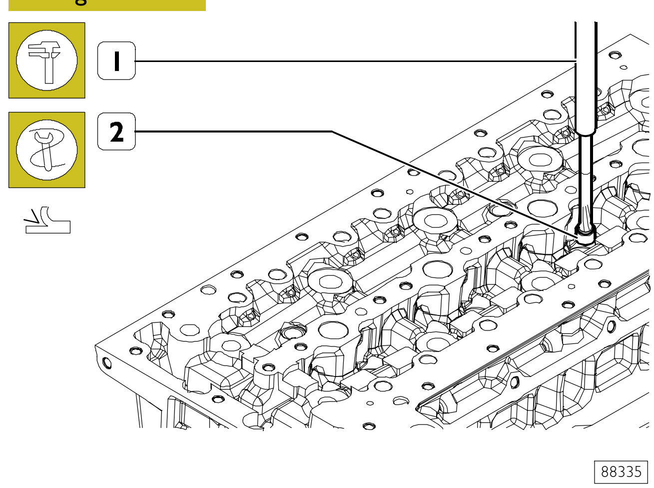
Figure 70



Warm up the cylinder head to 80° ÷ 100°C and, by means of beater SP.2312 (1) fitted with element SP.2311 (2), fit the new valve guides (3) previously lubricated with engine oil. Driving force 10 ÷ 25 KN.
If the above mentioned tools are not available, fit the valve guides by positioning them in the cylinder head according to the value shown in Figure 68.

Boring valve guides

Figure 71

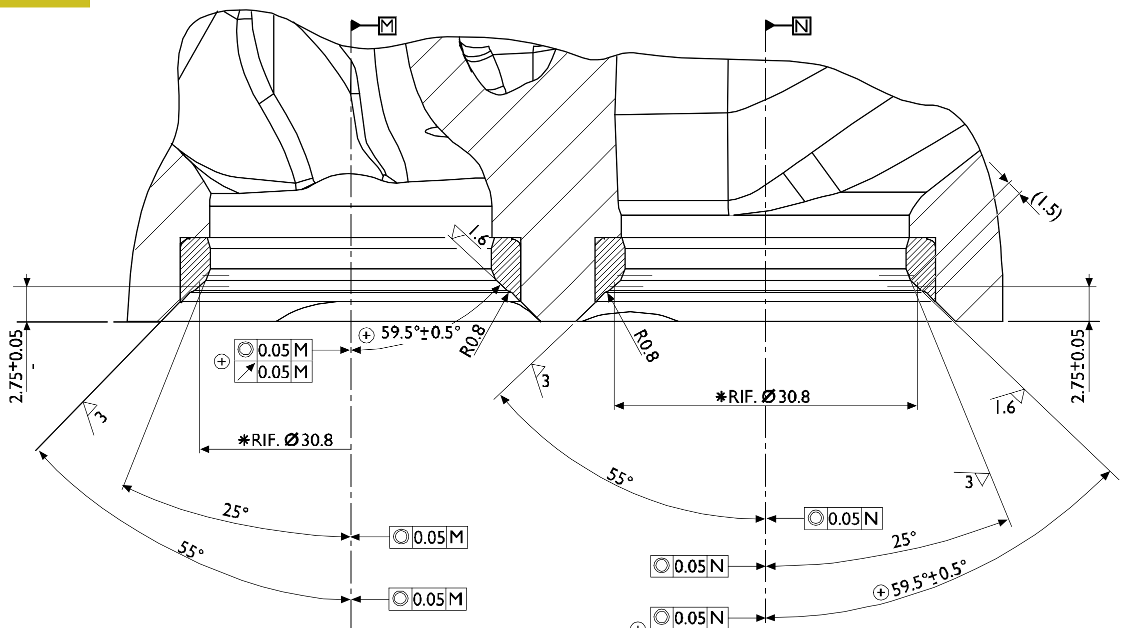


After driving in the valve guides (2), regrind them with the smoother SP.2310 (1).

VALVE SEATS

Regrinding - replacing valve seats

Figure 72

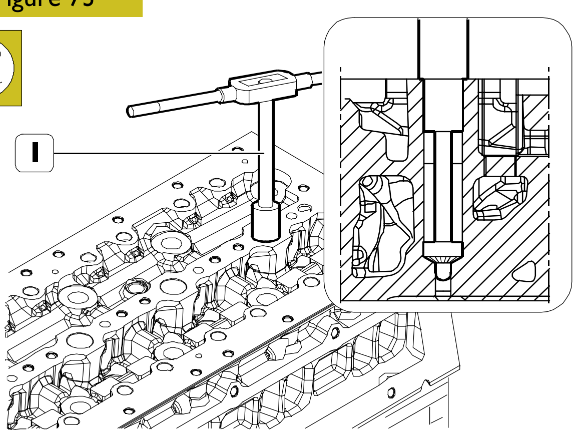


87801

Check the valve seats. On finding any slight scoring or burns, regrind them with an appropriate tool according to the angles given in Figure 72.
Having to replace them, with the same tool and taking care not to affect the cylinder head, remove as much material from the valve seats as possible until, with a punch, it is possible to extract them from the cylinder head.

Heat the cylinder head to 80 ÷ 100°C and, using a suitable drift, fit in it the new valve seats, previously chilled in liquid nitrogen.
Using a specific tool, regrind the valve seats according to the angles given in Figure 72.

Figure 73

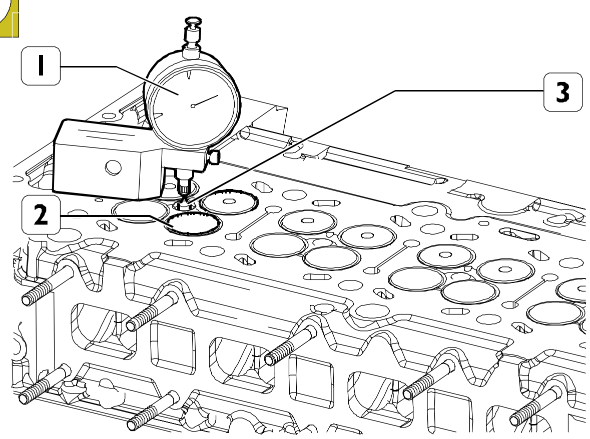


88336

Using the milling cutter 99394038 (1), clean the injector seat of any deposits.

Mount the valves, block the seat of the electro-injectors and glow plugs; using a suitable tool, check the seal of the valves/seats.

Figure 74



88337

Using a dial gauge (1), check that, from the plane of the cylinder head, the valve recessing (2) and the protrusion of the injector (3) and of the glow plug have the prescribed value:

- Valve recessing: 0.375 ÷ 0.525 mm.
- Injector protrusion: 2.77 ÷ 3.23 mm.
- Glow plug protrusion: 3.78 mm.

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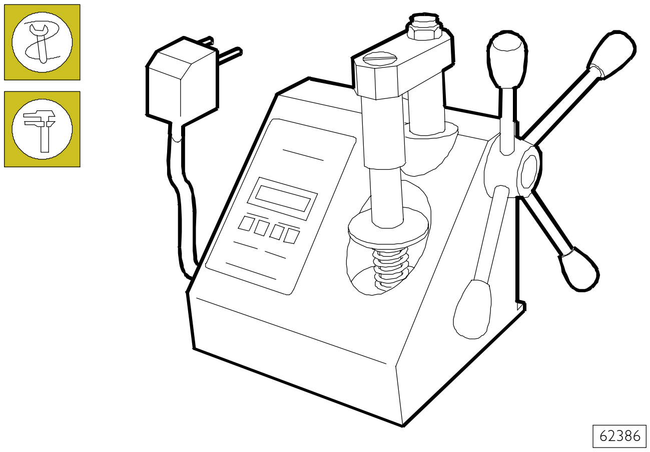
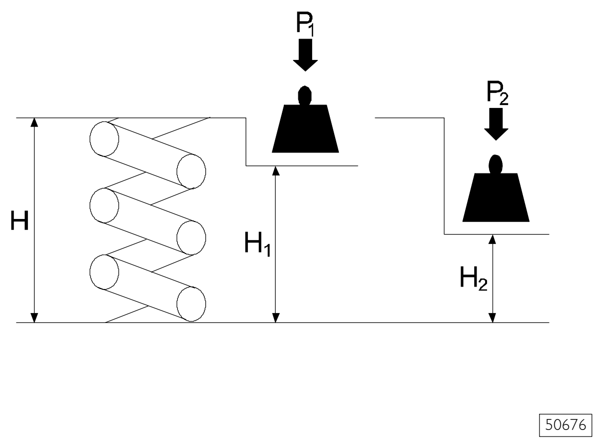
VALVE SPRINGS

Figure 75



Before assembly, check the flexibility of the valve springs with the tool 99305047. Compare the load and elastic deformation data with those of the new springs given in the following figures.

Figure 76

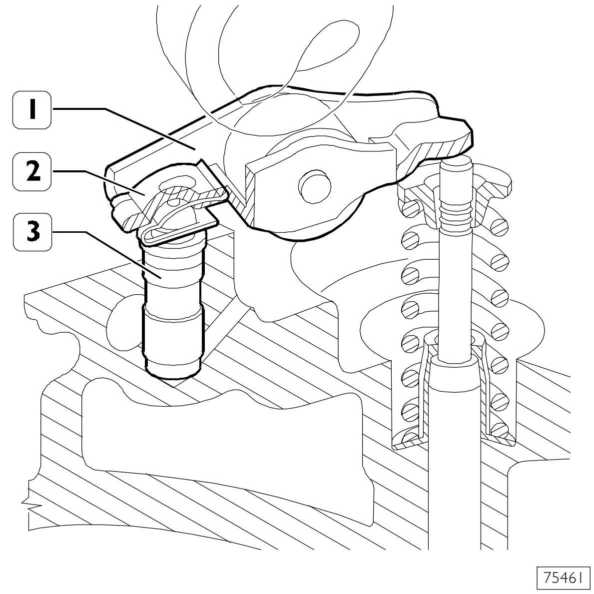


MAIN DATA TO CHECK INTAKE AND EXHAUST VALVE SPRINGS

Height	Under a load of
mm	kg
H 54	Free
H1 45	P 243 ±12
H2 35	P1 533 ±24

ROCKER ARMS – TAPPETS

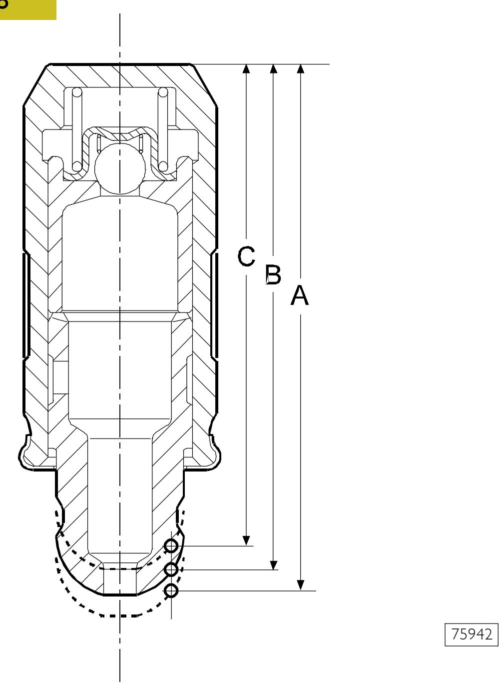
Figure 77



COMPLETE ROCKER ARM ASSEMBLY

The rocker arm assembly is composed of the rocker arm (1), hydraulic tappet (3), made integral with each other by the clip (2).

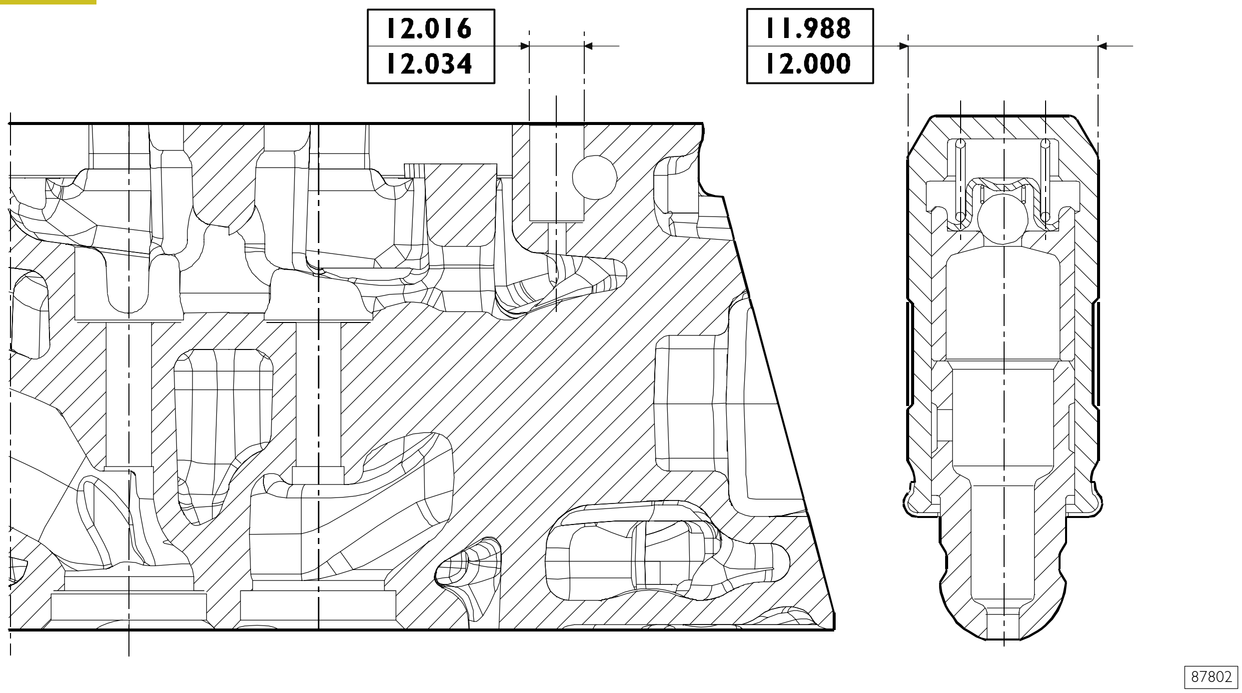
Figure 78



CROSS-SECTION OF THE HYDRAULIC TAPPET

A = 32.44 ±0.3, end of stroke
B = 31.30, working position
C = 29.75 ±0.25, start of stroke

Figure 79



MAIN DATA HYDRAULIC TAPPETS – SEATS

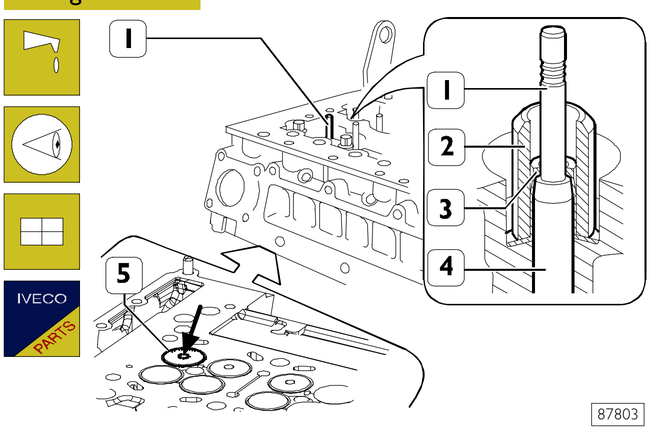
Checks

The sliding surface of the tappets must have no scoring/dents; replace them if they do.

Using a micrometer, measure the diameter of the tappets and, using a bore meter, measure the diameter of the seats in the cylinder head; the difference in the measurements will give the assembly clearance.

ASSEMBLING CYLINDER HEADS

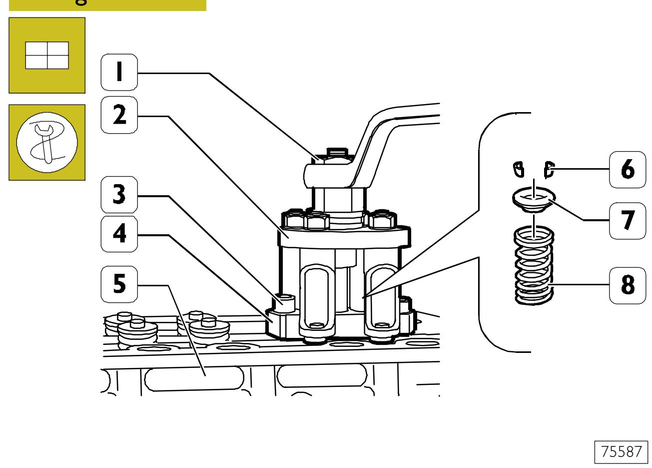
Figure 80



Lubricate the stem of the valves (1) and insert them into the associated valve guides (4) according to the position marked during removal. Using tool SP.2264 (2), mount the oil seals (3) on the valve guides (4).

NOTE The suction valves (5) are different from the exhaust ones for a slot (→) in the centre of the valve head.

Figure 81



Position the springs (8) and plates (7) on the cylinder head (5).

Fit the part (4) of tool 99360260 onto the cylinder head (5) and secure it with the screws (3).

Fit the part (2) of tool 99360260 onto part (4), screw down the nut (1) so that by compressing the springs (8) it is possible to insert the retaining cotters (6); then unscrew the nut (1) checking that the cotters (6) have settled in correctly.

Repeat these operations on the remaining valves.

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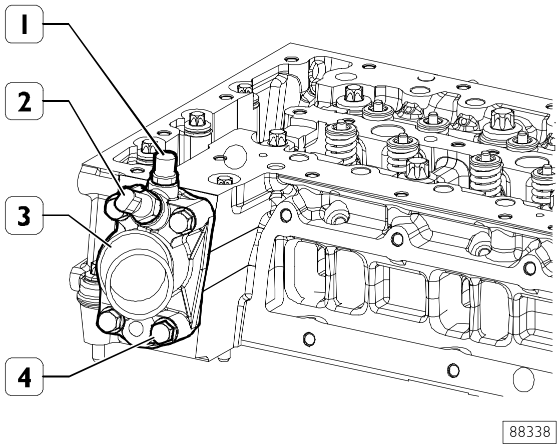
Figure 82



Fit the thermostat casing (3) with a new seal and tighten the fixing screws (4) to the prescribed torque.

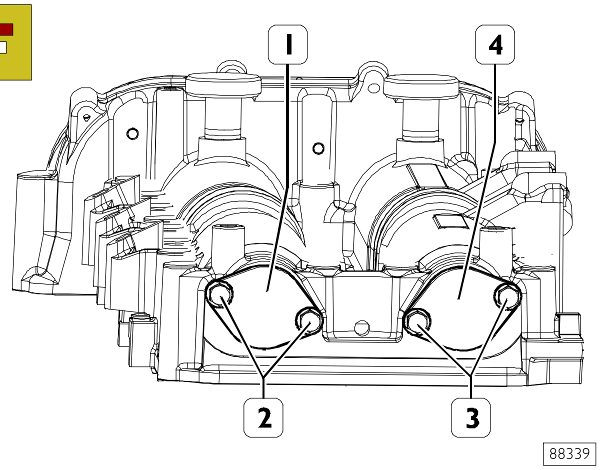
Fit the temperature sensors (1 and 2) and tighten them to the prescribed torque.

Fit the brackets for lifting the engine and tighten the fixing screws to the prescribed torque.

Overhead

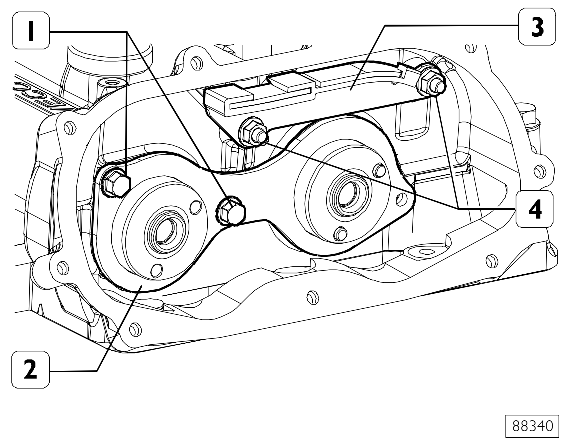
Overhead removal

Figure 83



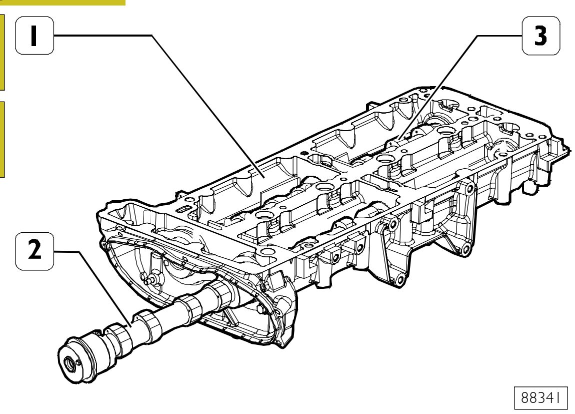
Remove the screws (2 and 3) and the covers (1 and 4) together with the over-head seal rings.

Figure 84



Remove the nuts (4) and the top skid (3).
Remove the screws (1) and the shoulder plate (2).

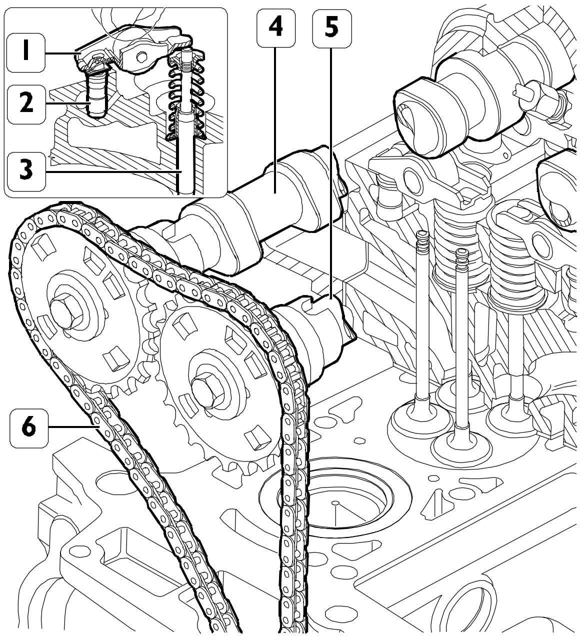
Figure 85



Tilt the over-head (1) and take care not to damage the seats, then take off the camshafts (2 and 3) from the overhead.

TIMING SYSTEM

Figure 86



1. Rocker arm - 2. Reaction hydraulic tappet - 3. Valve assembly - 4. Camshaft on exhaust side - 5. Camshaft on suction side - 6. Camshaft control chain.

Description

The timing system is the type with a twin camshaft in the head and four valves per cylinder with hydraulic tappets.

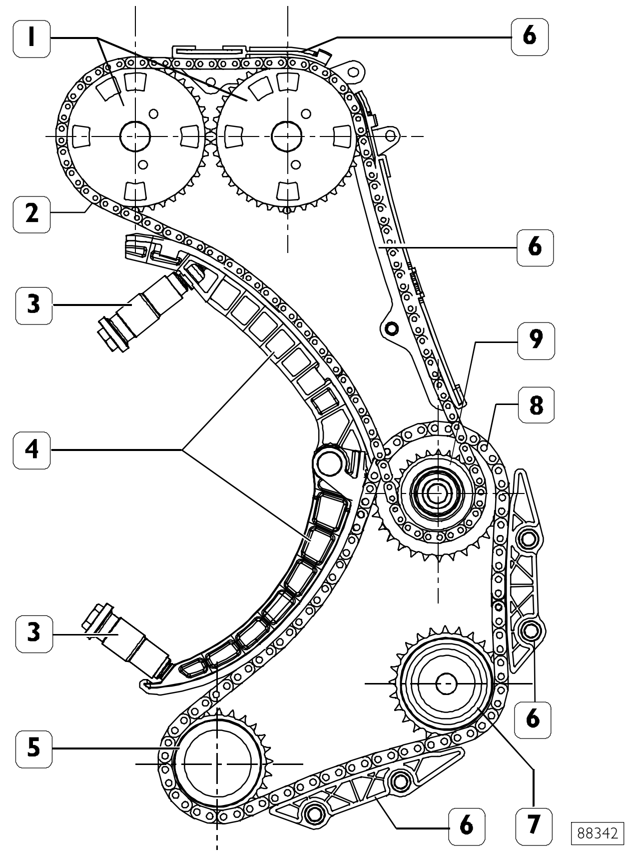
The control is transmitted by two chains:

- a double chain by 3/8" is set in motion by the driving shaft and sets the control shafts in motion: oil pump/depressor – high pressure pump;
- a single chain is set in motion by the high pressure control shaft gear and sets the camshafts in motion.

The camshaft gears are mutually interchangeable and are fitted with slots to make it possible for the phase sensor to detect the phase.
The rocker arms, one for the valve, are kept in contact with the corresponding cam by an hydraulic tappet, thus eliminating the need for regular adjustments.

NOTE Change both chains, even if only one of them is faulty.

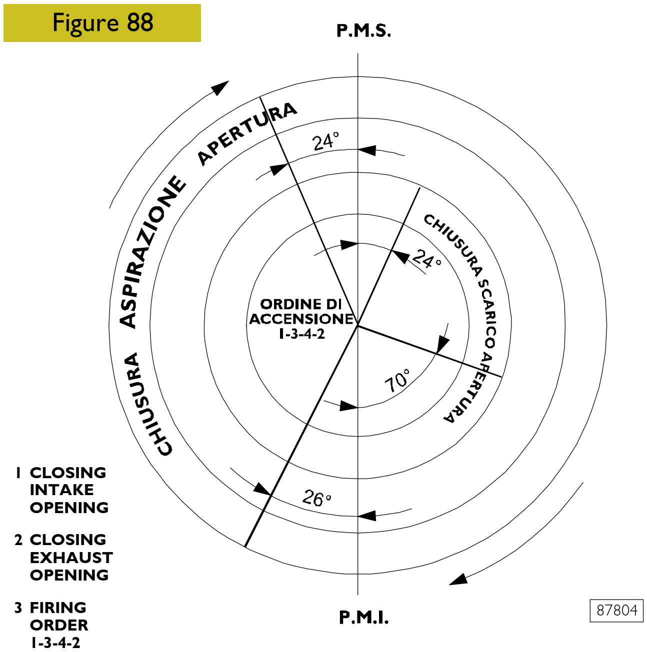
Figure 87



TIMING SYSTEM AND AUXILIARY SYSTEM DIAGRAM

1. Camshaft control gear - 2. Single chain - 3. Hydraulic chain tightener - 4. Chain - 5. Drive gear on driving shaft - 6. Fixed skid - 7. Oil pump/depressor control shaft gear – Hydraulic power steering pump - 8. Double chain - 9. High pressure pump control shaft gear.

Figure 88



TIMING SYSTEM DIAGRAM

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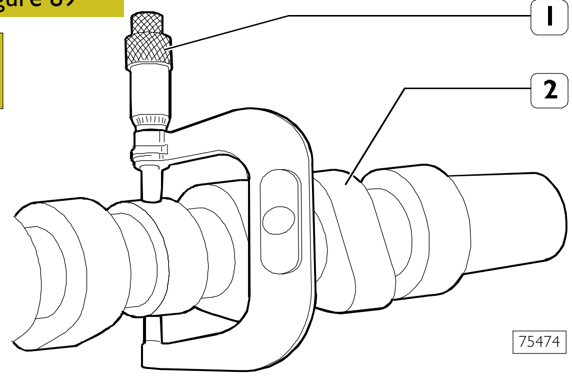
Camshaft
Checks

The surfaces of the shaft supporting pins and of the cams must be finely honed; if there is any sign of meshing or scoring, replace the shaft.

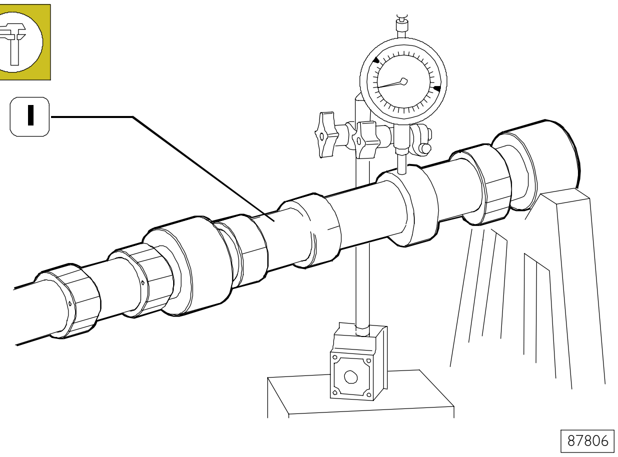
Figure 89



Using a micrometer (1), measure the diameter of the pins (2) of the camshaft and, using a bore meter, measure the diameter of the supporting seats in the overhead.
The difference between these two measurements gives the existing clearance.
The nominal assembly clearance is 0.037 ÷ 0.088 mm.

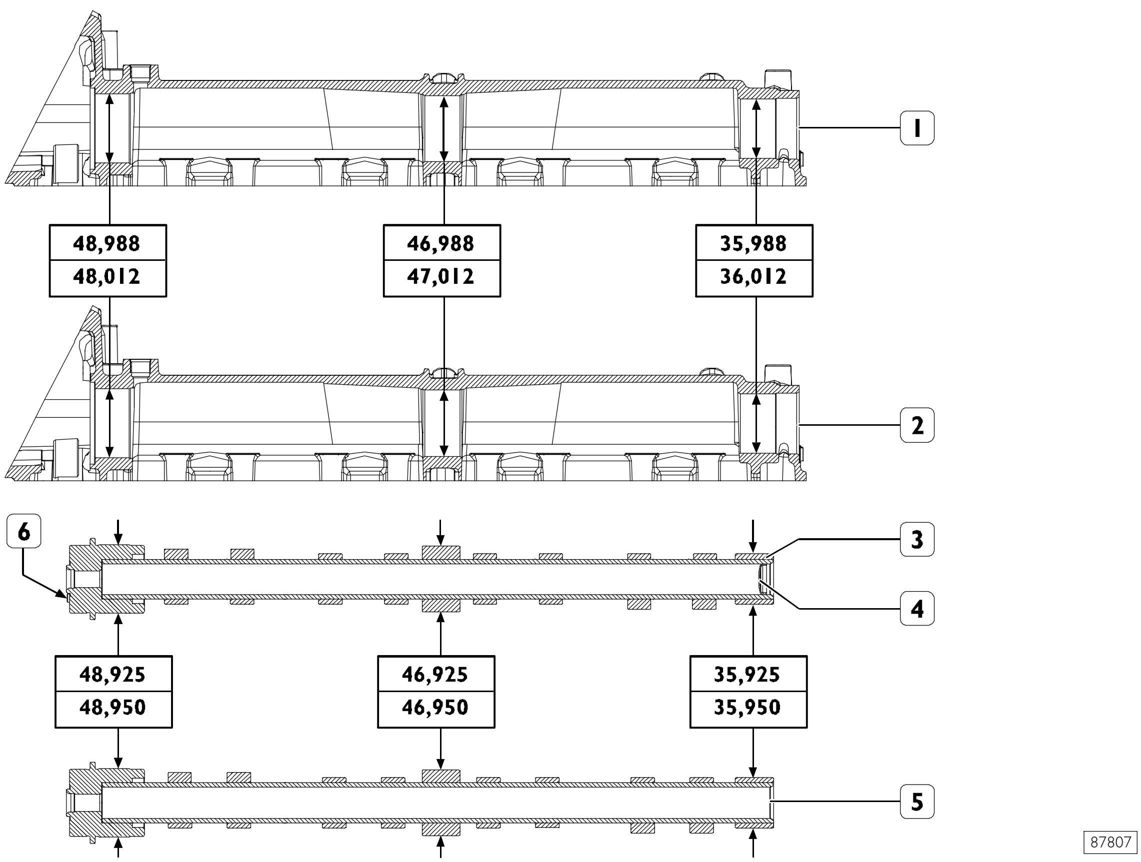
Checking cam lift and pin alignment

Figure 90



Place the shaft (1) on the parallels and use a centesimal dial gauge fitted on the central support to check that the alignment error does not exceed 0.04 mm; otherwise, change the shaft. Check also the cam lift: it must correspond to the prescribed value; if different values are detected, change the shaft.

Figure 91

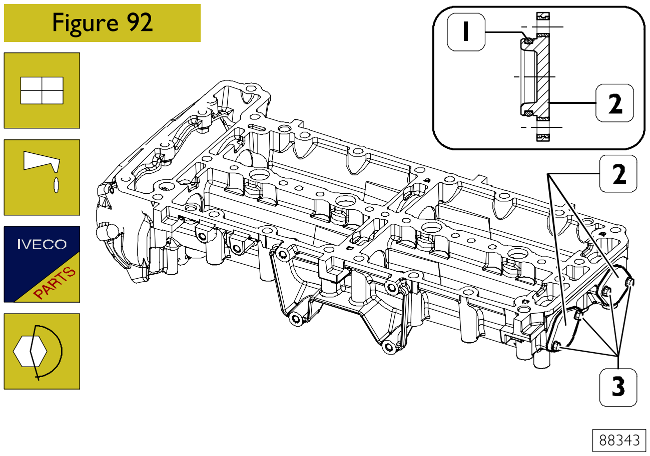


MAIN DATA, CAMSHAFT PINS AND SEATS
1. Intake valve camshaft seats – 2. Exhaust valve camshaft seats – 3. Intake valve camshaft – 4. Exhaust valve camshaft.

The camshaft (3) of the suction valves can be recognised through the spring cup (4) and the dowel (6).

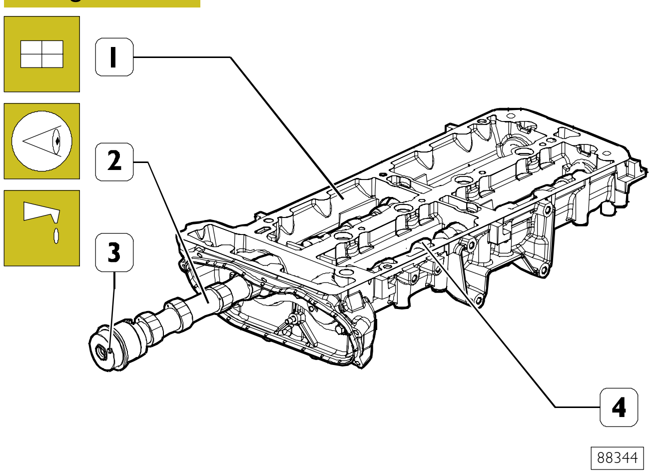
Assembling overhead

Figure 92



Lubricate the new seal rings (1) with engine oil and fit them on the covers (2).
Fit the covers (2) on the overhead, drive in the fastening screws (3) and tighten them to the prescribed torque.

Figure 93



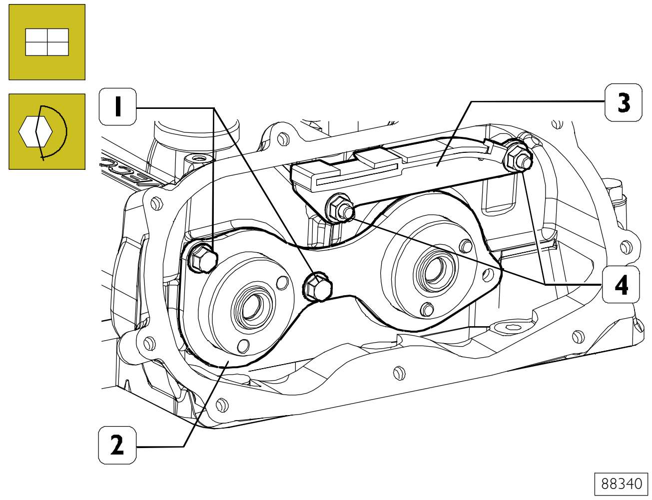
Lubricate the support pins of the suction camshafts (2) and exhaust camshafts (4) and fit them on the overhead (1).

NOTE During this operation do not exchange the assembly position of the shafts.

The suction camshaft can be recognised (2) through the dowel (3) on the front side and the retainer on the rear side.

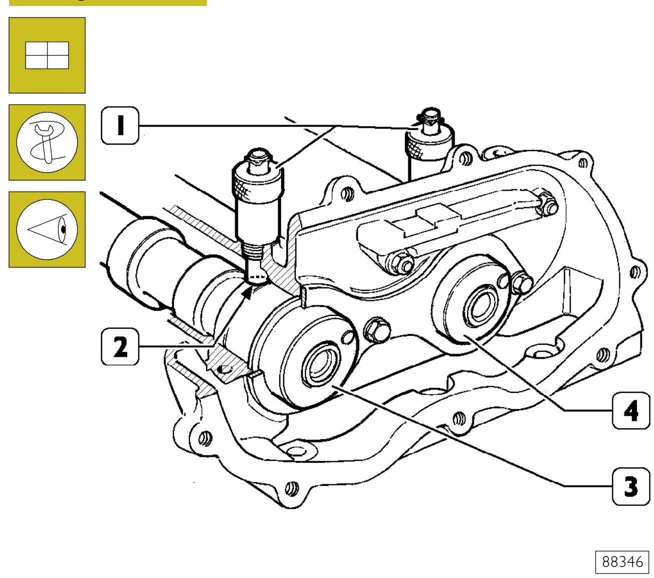
In addition, take care not to damage the support seats of the over-head shafts.

Figure 94



Fit the top skid (3) and drive in the nuts (4), then tighten them to the prescribed torque.
Fit the shoulder plate (2) and drive in the screws (1), then tighten them to the prescribed torque.

Figure 95



Position the camshafts (3 and 4) so that the pins 99360614 (1) can be inserted in the camshaft slots (2) through the over-head threaded holes.

TIGHTENING TORQUE

PART	TORQUE	
	Nm	kgm
M15x1.5 L 193 fastening screw for cylinder head inside		
First stage: pre-tightening	130	13
Second stage: angle	90°	
Third stage: angle	90°	
M12x1.5 L 165 fastening screw for cylinder head side		
First stage: pre-tightening	65	6.5
Second stage: angle	90°	
Third stage: angle	60°	
M8x1.25 L 117/58 fastening screw for side with chain compartment, cylinder head	25	2.5
R 1/2"bevel threaded cap with socket head	25	2.5
R 3/8" bevel threaded cap with socket head	17	1.7
R 1/4" bevel threaded cap with socket head	9	0.9
M26x1.5 threaded screw tap	50	5
Screw with flange M6x1 for camshaft rear cover fastening	10	1
Screw with flange M6x1 for camshaft shoulder plate fastening	10	1
Socket head screw with flange M8x1.25 L 30/40/77/100 for over-head fastening	25	2.5
M14x1.5 L 10 threaded screw tap	25	2.5
M6x1 socket head screw for timing system control cover	10	1
M12x1.5 L 125 inner fastening screw for lower cylinder block		
First stage: pre-tightening	50 ± 5	5 ± 0.5
Second stage: angle	60° ± 2.5°	
Third stage: angle	60° ± 2.5°	
M8x1.25 L 77.5/40 outer fastening screw for lower cylinder block	26	
Socket head screw with flange M11x1.25 for connecting rod cap fastening		
First stage: pre-tightening	50	5
Second stage: angle	70°	
Socket head screw with flange M12x1.25 for engine flywheel fastening		
First stage: pre-tightening	30	3
Second stage: angle	90°	
Socket cylinder head screw for phonic wheel fastening on drive shaft	15	1.5
Connection M10x1 for piston cooling nozzle	25	2.5
Bevel threaded cap with socket head R 3/8"x10 oil circuit	17	1.7
Socket head screw with flange M18x1.5 for drive shaft damper pulley fastening	350	35
Bevel cap R 1/8 x 8	7	0.7
Water draining plug M14x1.5 L10	25	2.5
Pipe union on block for oil return from turbocharger G 3/8" x 12	50	5
Suction rose M6x1 fastening screw	10	1
Socket head nut with flange M8x1.25 for depressor – oil pump unit support fastening	25	2.5
Oil pump – depressor unit control pin	110	11
Threaded cap M26x1.5	50	5
Socket head screw with flange M8x1.5 L35 for oil sump retaining frame fastening	25	2.5
Threaded screw tap with O-ring M22x1.5 L10	50 ±10	5 ±1
Socket head screw with flange M8x1.25 L60 for depressor - oil pump unit fastening	25	2.5
Socket head screw with flange M8x1.25 L50 for depressor - oil pump unit fastening	25	2.5
Flanged screw M8x1.25 L20/30 for camshaft cover fastening	25	2.5
Flanged screw M6x1 L20 for blow-by unit fastening	10	1
M14x1.5 L10 cap	25	2.5

PART	TORQUE	
	Nm	kgm
Socket head screw with flange M8x1.25 L40 for suction manifold fastening	30	3
Flanged nut M8x1.25 for exhaust manifold fastening	25	2.5
Socket cylinder head screw M8x1.25 L65 for Poli-V belt automatic backstand	25	2.5
Flanged screw M10x1.25 L22 for Poli-V belt take-up pulley fastening	40	4
Flanged head M12x1.75 L30 for camshaft gear fastening	80	8
Timing chain tightener fastener M22x1.5	50	5
Timing chain mobile skid fastener	40	4
Socket cylinder head screw M8x1.25x30 for fixed skid fastening	25	2.5
Socket cylinder head screw M6x1 L16/20 for skid fastening	10	1
Socket cylinder head screw M12x1.5 for water temperature/pressure sensor fastening Zylinderschraube mit Innensechskant M12x1,5 des Wassertemperatur-/-drucksensors	30	3
Socket cylinder head screw M6x1.5 for air temperature/pressure sensor fastening	10	1
Socket cylinder head screw M6x1 for engine rev sensor fastening	10	1
Socket head screw M6x1 for phase sensor fastening	10	1
High-pressure injection system Flanged nut M8x1.25 for high pressure pump support fastening	25	2.5
Hydraulic accumulator fastening screw M8x1.25 L50	28	2.8
High pressure pump fastening screw M8x1.25 L58	25	2.5
Screw M8x1.25 for fastening of fuel delivery pipe anchoring bracket	25	2.5
Pipe union for fuel delivery pipes to rail and electric injectors: - M14x1.5 - M12x1.5	 19 ± 2 25 ± 2	 1.9 ± 0.2 2.5 ± 0.2
Socket cylinder head screw for fastening of electric injector retaining bracket	28	2.8
Flanged nut for anchoring bracket support fastening	25	2.5
Pin fastener M12x1.25 for high pressure pump	110	11
Flanged screw M6x1 for low pressure fuel pipe fastening	10	1
Flanges screw M8x1.25 for pipe support bracket fastening	40	4
Filler neck M12x1.5 for adjustable pipe union	25	2.5
Filler neck M16x1.5 for adjustable pipe union	40	4
Pipe union for multi-way filler fastening to high pressure pump M12x1.5 L24	25	2.5
Nut M8x1.25 for turbocharger fastening	25	2.5
Flanged screw M8x1.25 for turbocharger output pipe fastening	25	2.5
Pipe union M14x1.5 or M12x1.5 for oil delivery pipe to turbocharger	35	3.5
Pipe union M22x1.5 for oil return pipe from turbocharger	45	4.5
Flanged screw for fastening of oil return pipe from turbocharger	10	1
Pipe union M14x1.5 for fastening of oil delivery pipe to turbocharger	35	3.5
Screw M8x1.25 for air inlet bracket fastening	28	2.8
Screw M8x1.25 for air inlet bracket fastening	28	2.8
Socket cylinder head screw M6x1 for V-clamp closing ring	8	0.8
Flanged screw M6x1 for oil inlet pipe fastening	10	1
Pre-warming plug M8x1	8 ÷ 11	0.8 ÷ 1.1
Screw M8x1.25 for electric injector retaining bracket fastening	28	2.8
Oil filter cartridge M22x1.5	25	2.5
Socket cylinder head screw M8x1.25 for water inlet pipe fastening	25	2.5

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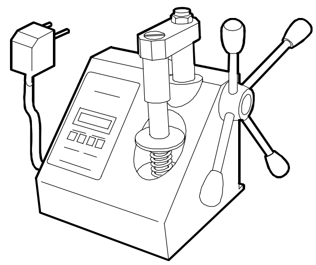
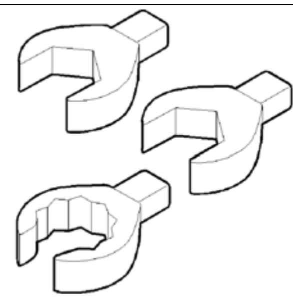
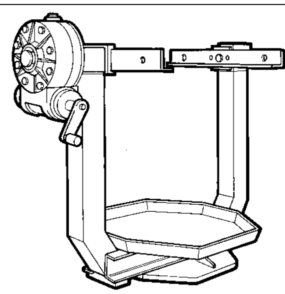
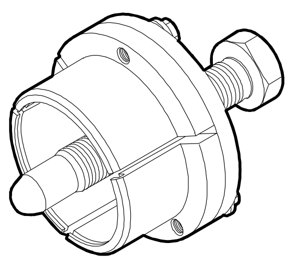
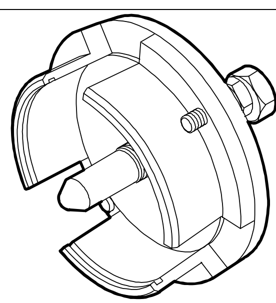
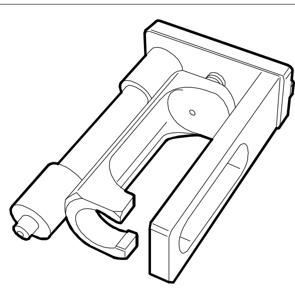
PART	TORQUE	
	Nm	kgm
Pipe union M24x1.5 for oil filter cartridge	30	3
Flanged screw M8x1.25 for heat exchanger inner element fastening	25	2.5
Socket cylinder head screw for water pump fastening: - M10x1.5 - M8x1.25	 50 25	 5 2.5
Flanged screw M8x1.25 for rear cover fastening to cylinder head	25	2.5
Flanged screw M8x1.25 for coolant delivery pipe fastening	25	2.5
Flanged nut M8x1.25 for coolant delivery pipe support bracket fastening	25	2.5
Pipe union M10x1x10 for vapour vent fastening	12	1.2
Flanged screw M8x1.25 for thermostat fastening	25	2.5
Flanged nut M6x1 for electro-magnetic joint fastening	10	1
Ring nut M30x1.5 for electro-magnetic joint	150	15
Flanged screw M8x1.25 for air conditioner compressor fastening	25	2.5
Flanged screw M8x1.25 L50 for air conditioner compressor support fastening	25	2.5
Socket cylinder head screw M8x1.25 for fastening of air conditioner compressor control belt idler	25	2.5
Socket cylinder head screw M10x1.5 for alternator fastening	50	5
Flanged screw M8x1.25 for hydraulic power steering pump fastening	25	2.5
Flanged screws M8x1.25 for power take off cover fastening	25	2.5
Flanged screws M8x1.25 for handling hook fastening	25	2.5
Flanged screws M10x1.25 for engine support fastening	50	5
Depressor pipe union M14x1.5	35	3.5
Oil level sensor M12x1.25	25	2.5
Thermometric transmitter/switch M16x1.5 (conical)	25	2.5
Oil pressure switch M14x1.5	40	4

* On the threading apply LOCTITE 577

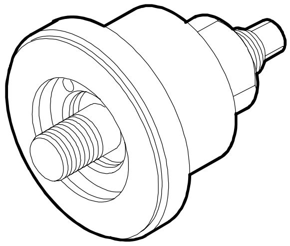
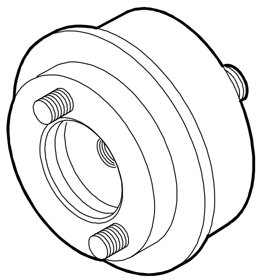
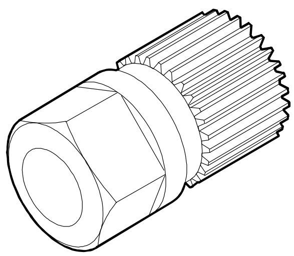
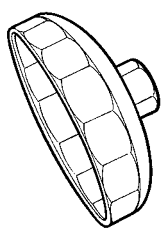
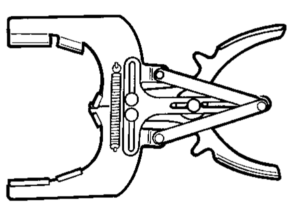
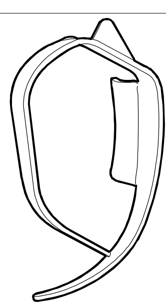
SECTION 5

Tools

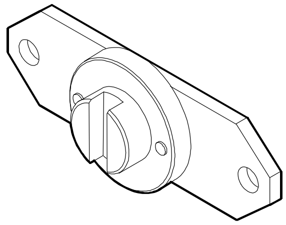
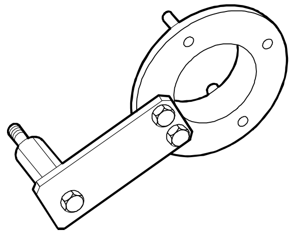
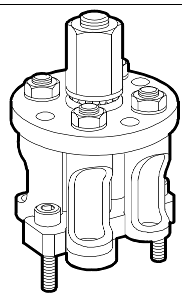
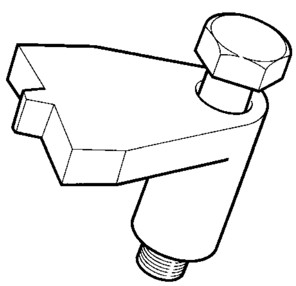
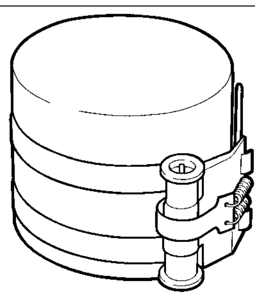
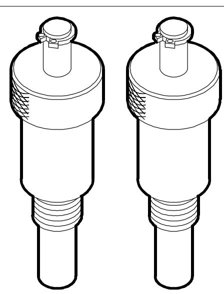
TOOLS

TOOL NO.		DESCRIPTION
99305047		Appliance to check spring loads
99317915		Set of six box-type wrenches (14-17-19 mm)
99322205		Rotary telescopic stand for overhauling assemblies (capacity 700 daN, torque 120 daN/m)
99340059		Extractor for camshaft pulley
99340060		High-pressure pump toothed pulley extractor
99342153		Tool to remove crankshaft front gasket

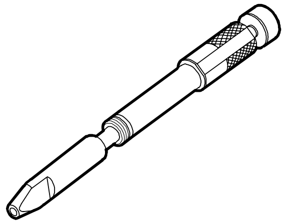
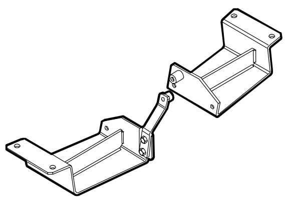
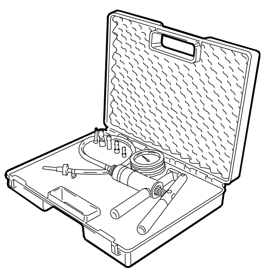
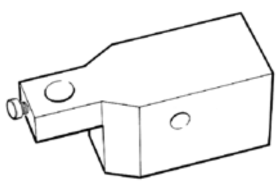
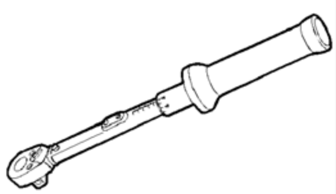
TOOLS

TOOL NO.		DESCRIPTION
99346258		Keying device for mounting crankshaft front gasket
99346259		Keying device for mounting crankshaft rear gasket
99358026		Wrench for alternator pulley (free wheel) removal/refitting
99360076		Tool to remove cartridge filters
99360183		Pliers for mounting rings on engine pistons
99360186		Guide for flexible belt

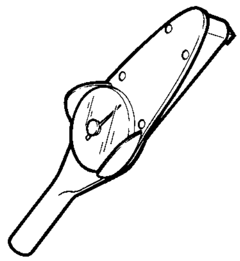
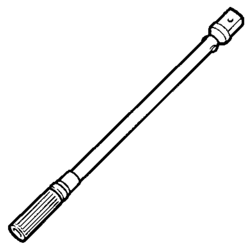
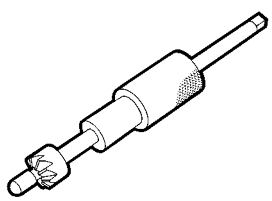
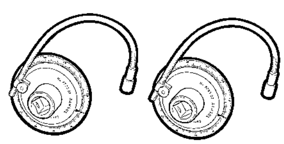
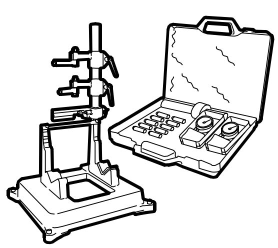
TOOLS

TOOL NO.		DESCRIPTION
99360187		Retaining tool for hydraulic power steering control shaft
99360190		Damper pulley retaining tool
99360260		Tool for removing and refitting engine valves
99360306		Tool to retain engine flywheel
99360605		Band to insert standard and oversized pistons into the cylinders
99360614		Tool (2) for camshaft timing

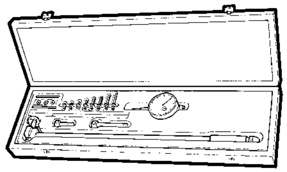
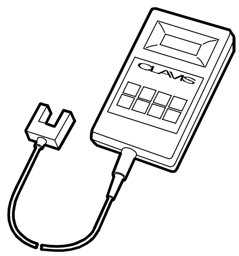
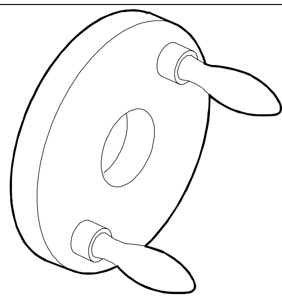
TOOLS

TOOL NO.		DESCRIPTION
99360615		Tool for crankshaft timing
99361041		Brackets securing engine to rotary stand 99322205
99367121		Manual pump to measure pressure and vacuum
99370415		Dial-gauge base for various measurements (to be used with 99395603)
99389817		Dynamometric wrench (60 ÷ 320 Nm) with 3/4'' coupling
99389818		Dynamometric wrench (150-800 Nm) with 3/4'' square coupling

TOOLS

TOOL NO.		DESCRIPTION
99389819		Torque wrench (0-10 Nm) with square 1/4" connection
99389829		9x12 coupling torque wrench (5-60 Nm)
99394038		Milling cutter to regrind injector seat
99395216		Pair of meters for angular tightening with square 1/2" and 3/4" connection
99395363		Complete square to check for connecting rod distortion
99395603		Dial gauge (0-5 mm)

TOOLS

TOOL NO.		DESCRIPTION
99395687		Bore meter (50 – 178 mm)
99395849		Belt tension control device (frequency from 10.0 bis 600 Hz)
99396039		Centring ring for timing gear cover

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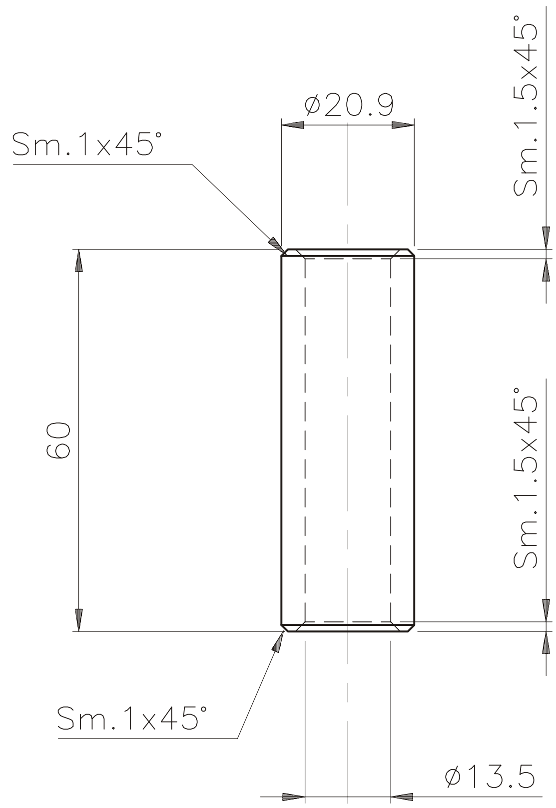
EXPERIMENTAL TOOLS

This section shows the working drawings for the experimental tools (S.P.) used in overhauling the engine described in this section, which may be made by the repair shops.



Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT.	COVER.	DRAWN	N°DRAWING
Pom / Nylon	**/**	**UTS (B)**	**SP. 2264**

Perni di centraggio sovratesta e per piantaggio guarnizione guida valvole

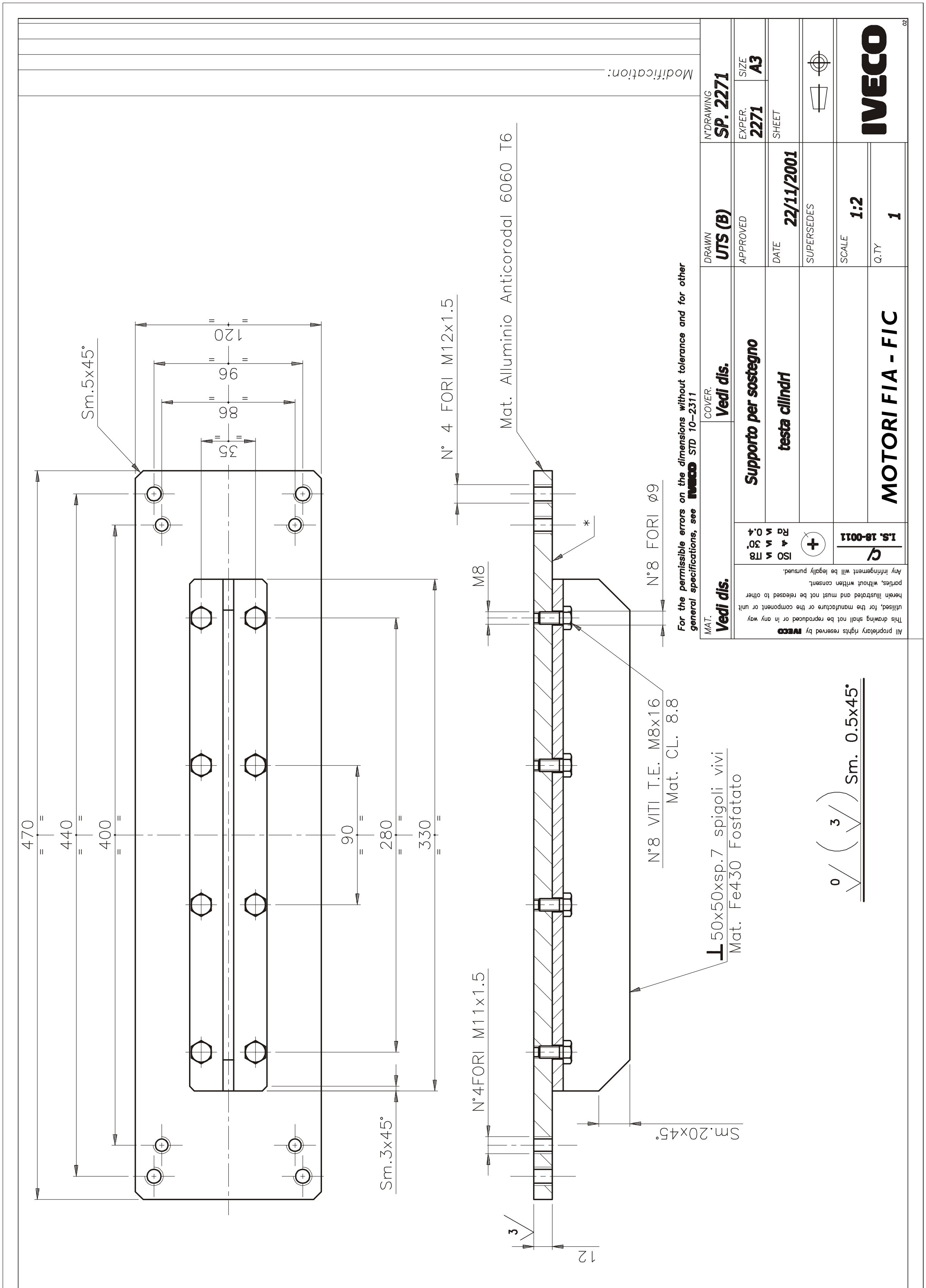
ISO ≤ IT8
∢ ≤ 30'
Ra ≤ 0.4

C/
I.S. 18-0011

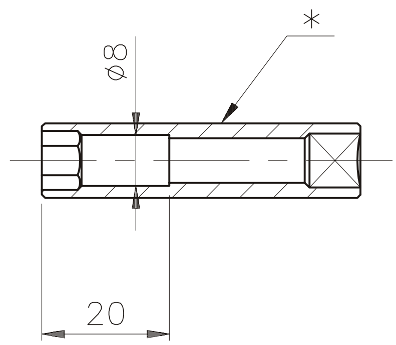
MOTORI F1A - F1C

APPROVED		EXPER. **2264**	SIZE **A4**
DATE	**19/06/2001**	SHEET	
SUPERSEDES			
SCALE	**1:1**	IVECO	
Q.TY	**2**		

02


Modification:
N°DRAWING SP. 2271
SIZE A3
EXPER. 2271
SHEET
IVECO
DRAWN UTS (B)
APPROVED
DATE 22/11/2001
SUPERSEDES
SCALE 1:2
Q.TY 1
MAT. Vedi dis.
COVER. Vedi dis.
Supporto per sostegno
testa cilindri
MOTORI F1A - F1C
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10-2311
I.S. 18-0011
Mat. Alluminio Anticorodal 6060 T6
N° 4 FORI M12x1.5
N°8 FORI Ø9
M8
N°8 VITI T.E. M8x16
Mat. CL. 8.8
⊥50x50xsp.7 spigoli vivi
Mat. Fe430 Fosfatato
Sm. 0.5x45°
N°4FORI M11x1.5
Sm.5x45°
Sm.3x45°
Sm.20x45°
470
440
400
90
280
330
120
96
86
35
12

VARIA DA ART. COMMERCIALE USAG cod.235EL 1/4" – Ch.8
SOLO PER QUANTO INDICATO

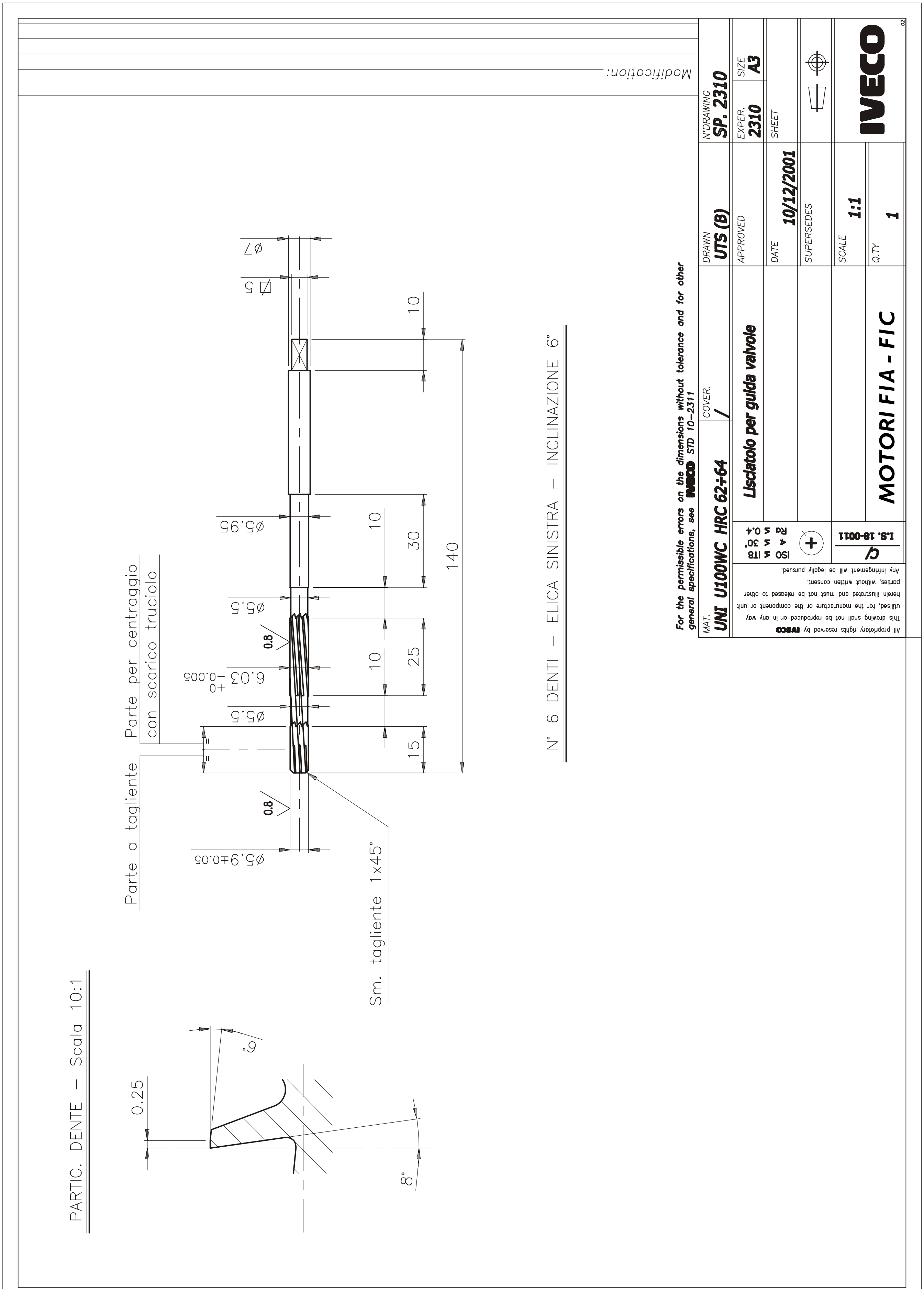


6 √ Sm. 0.5x45°

Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. /	COVER. /	DRAWN UTS (B)	N°DRAWING SP. 2275
ISO ≤ IT8 / ∢ ≤ 30' / Ra ≤ 0.4	**Bussola (8 mm) per montaggio/ smontaggio candelette**	APPROVED	EXPER. 2275 / SIZE A4
		DATE 25/07/2001	SHEET
		SUPERSEDES	
C/ I.S. 18-0011		SCALE 1:1	IVECO
	MOTORI F1A - F1C	Q.TY 1	02


Modification:
PARTIC. DENTE - Scala 10:1
0.25
6°
8°
Sm. tagliente 1x45°
Parte a tagliente
Parte per centraggio con scarico truciolo
ø5.9±0.05
0.8
0.8
ø5.5
6.03 +0 −0.005
ø5.5
ø5.95
□5
ø7
15
10
25
10
30
10
140
N° 6 DENTI - ELICA SINISTRA - INCLINAZIONE 6°
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10-2311
MAT. UNI U100WC HRC 62÷64
COVER. /
DRAWN UTS (B)
N°DRAWING SP. 2310
Lisciatolo per guida valvole
APPROVED
EXPER. 2310
SIZE A3
DATE 10/12/2001
SHEET
SUPERSEDES
SCALE 1:1
Q.TY 1
MOTORI F1A - F1C
I.S. 18-0011
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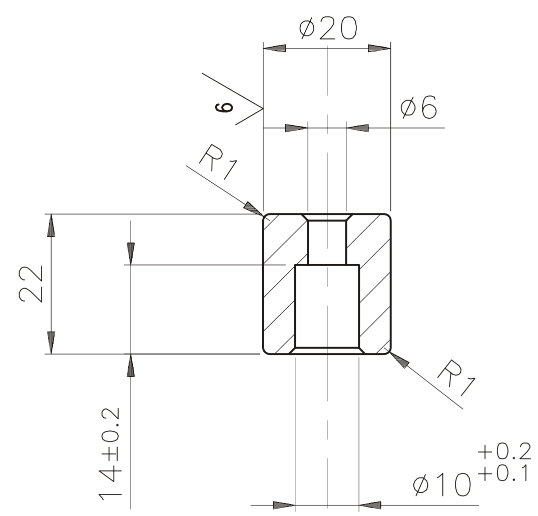
IVECO



Modification:

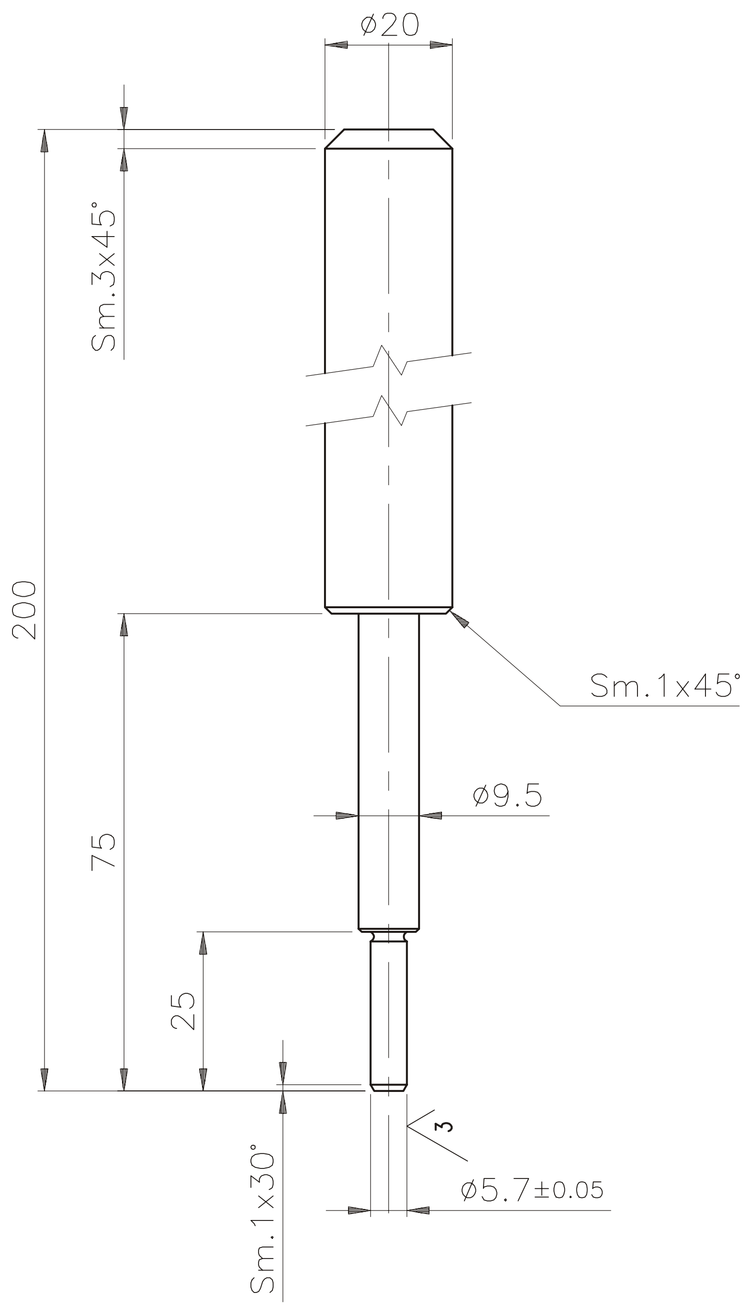
For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT. 39NiCrMo3 Bon.	COVER. Fosfat.	DRAWN UTS (B)	N°DRAWING SP. 2311
Battitoio per piantaggio		APPROVED	EXPER. 2311 / SIZE A4
guida valvole		DATE 10/12/2001	SHEET
(usare con sp. 2312)		SUPERSEDES	
		SCALE 1:1	IVECO
MOTORI F1A - F1C		Q.TY 1	

ISO ≤ IT8
∢ ≤ 30'
Ra ≤ 0.4

C/
I.S. 18-0011

02



Modification:

For the permissible errors on the dimensions without tolerance and for other general specifications, see IVECO STD 10–2311

MAT.	COVER.	DRAWN	N°DRAWING	
39NiCrMo3 Bon.	**Fosfat.**	**UTS (B)**	**SP. 2312**	
ISO ≤ IT8 / ∢ ≤ 30' / Ra ≤ 0.4	**Battitoio per spiantaggio**	APPROVED	EXPER. **2312**	SIZE **A4**
	guida valvole	DATE **10/12/2001**	SHEET	
		SUPERSEDES		
C/ **I.S. 18-0011**		SCALE **1:1**	IVECO	
	MOTORI F1A - F1C	Q.TY **1**		

02

Appendix

SAFETY PRESCRIPTIONS
Standard safety prescriptions

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in-charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

- Keep working areas as clean as possible, ensuring adequate aeration.
- Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- Smoking in working areas subject to fire danger must be strictly prohibited.
- Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- Wear safety gloves and goggles when performing the following operations:
  - filling inhibitors or anti-frost
  - lubrication oil topping or replacement
  - utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- Wear safety helmet when working close to hanging loads or equipment working at head height level.
- Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- Use protection cream for hands.
- Change wet cloths as soon as possible
- In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.
- Do not smoke nor light up flames close to batteries and to any fuel material.
- Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- Do not execute any intervention if not provided with necessary instructions.
- Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50ºC.
- Never top up an overheated engine with cooler and utilize only appropriate liquids.
- Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- Do not leave rags impregnated with flammable substances close to the engine.
- Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- Do not utilize fast screw-tightening tools.
- Never disconnect batteries when the engine is running.
- Disconnect batteries before any intervention on the electrical system.
- Disconnect batteries from system aboard to load them with the battery loader.
- After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- Do not disconnect and connect electrical connections in presence of electrical feed.
- Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

- Avoid incorrect tightening or out of couple. Danger: incorrect tightening may seriously damage engine's components, affecting engine's duration.
- Avoid priming from fuel tanks made out of copper alloys and/or with ducts not being provided with filters.
- Do not modify cable wires: their length shall not be changed.
- Do not connect any user to the engine electrical equipment unless specifically approved by Iveco.
- Do not modify fuel systems or hydraulic system unless Iveco specific approval has been released. Any unauthorized modification will compromise warranty assistance and furthermore may affect engine correct working and duration.

For engines equipped with electronic gearbox:

- Do not execute electric arc welding without having priory removed electronic gearbox.
- Remove electronic gearbox in case of any intervention requiring heating over 80°C temperature.
- Do not paint the components and the electronic connections.
- Do not vary or alter any data filed in the electronic gearbox driving the engine. Any manipulation or alteration of electronic components shall totally compromise engine assistance warranty and furthermore may affect engine correct working and duration.

Respect of the Environment

- Respect of the Environment shall be of primary importance: all necessary precautions to ensure personnel's safety and health shall be adopted.
- Be informed and inform the personnel as well of laws in force regulating use and exhaust of liquids and engine exhaust oil. Provide for adequate board indications and organize specific training courses to ensure that personnel is fully aware of such law prescriptions and of basic preventive safety measures.
- Collect exhaust oils in adequate specially provided containers with hermetic sealing ensuring that storage is made in specific, properly identified areas that shall be aerated, far from heat sources and not exposed to fire danger.
- Handle the batteries with care, storing them in aerated environment and within anti-acid containers. Warning: battery exhalation represent serious danger of intoxication and environment contamination.

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